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*Photograph by Messrs. Illo*

**W. NOWELL, C.M.G., C.B.E.**

THE  
EMPIRE COTTON GROWING<sup>195</sup>  
REVIEW

Vol. XXXV

JANUARY 1958

No. 1

**RETIREMENT OF MR. W. NOWELL, C.M.G., C.B.E.**

MR. NOWELL retired on December 31, 1957, after having edited the EMPIRE COTTON GROWING REVIEW for seventeen years. The Corporation owe him a very considerable debt for the high standard which he has maintained. Mr. Nowell undertook this task at a difficult time; he determined, however, that in spite of paper rationing the Review should not lapse during the war, but be carried on in a series of Abstract numbers. Publication in the pre-war form was resumed in April 1946. Mr. Nowell had already had experience of editing a periodical concerned with agriculture, as he started the *East African Agricultural Journal* while he was at Amani and edited it until he retired in 1936.

After taking his degree at the Royal College of Science, where he had worked under Sir John Farmer and Professor Maxwell Lefroy, Nowell was appointed Assistant Superintendent of Agriculture, Barbados, in 1911. Here he soon came into contact with cotton, as he was placed in charge of a campaign against a widespread outbreak of leaf blister mite. In 1913 he became Mycologist in the West Indian Imperial Department of Agriculture, and in 1920 was appointed Assistant Director of Agriculture, Trinidad, which post he held until 1926. In 1923 he published "Diseases of Crop Plants in the Lesser Antilles," which still remains a standard work.

In 1926 Nowell established what must surely be a record, for after twenty-eight days as Director of Agriculture, British Guiana, he was translated to Africa as Director of the East African Agricultural Research Station, Amani. Of his term there, Dr. H. H. Storey, as Acting Director, wrote in the Annual Report of the Station for 1936-37: "In April 1936 Mr. W. Nowell left, pending retirement from the Directorship after ten years' service to the Station. He found Amani scientifically derelict; under his guidance it changed first to a going concern still uncertain of recognition and hampered by grave material difficulties; and at length he left a Research Station in fruitful and enthusiastic working, with world-wide scientific connections."

Mr. Nowell was awarded the C.B.E. in 1929, the C.M.G. in 1936, and was elected an honorary Fellow of the Imperial College of Science and Technology in 1953. He was Chairman of the West African Cocoa Commission in 1938, a member of the Scientific Advisory Committee of the Corporation from 1938 to 1952, and has been a member of the Governing Body of the Imperial College of Tropical Agriculture since 1941.

J.C.M.

# COTTON AGRONOMY TRIALS IN THE NORTHERN AND EASTERN PROVINCES OF UGANDA: 1925-56

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IN THE Northern and Eastern Provinces of Uganda investigations both of cotton varieties and of the crop's agronomy have centred on Serere Experiment Station. This station was started by R. G. Harper in 1920 with the object of continuing cotton research initiated at Kadunguru (1911-15) and Simsia (1916-19). Until 1930 Serere served as the principal cotton experiment station for the whole Protectorate. Then, due to an expansion of the cotton acreage in Buganda Province, experimental work for areas west of the Nile was started at Bukalasa (Tothill, 1940).

Botanists in the Uganda Government service continued to work on cotton growing and breeding problems at Serere until 1956. An officer of the Empire Cotton Growing Corporation was then appointed, from the Corporation's Central Research Station at Namulonge, to take over this aspect of the station's work.

## Data

The results of 133 cotton agronomy trials conducted at various centres in the Northern and Eastern Provinces during the thirty-two-year period 1925-56 were available in the records of the Cotton Breeding Section at Serere. The majority of these trials were sown on the station; fifty-two trials had, however, been planted on outstations which included Ngetta, Aduku, Kaberamaido, Katakwi, Toroma, Mbale, Wanyange and Kamage.

Many of the trials had been analysed and recorded in the annual reports of the Department of Agriculture. The object in reconsidering these data is to integrate the individual experiments and to determine general overall trends. Where possible, the results are also considered in their application to the various districts of the two Provinces. Long-term fertility and manurial experiments are not considered here, since the inclusion of numerous crops other than cotton places them outside the scope of this paper.

The experiments may be conveniently divided into four groups; planting date trials, plant population experiments, ridging trials and a small miscellaneous group. In this form the results are presented below. In order to remove seasonal and environmental variations, which were large, plot yields or treatment means have been expressed as percentages of the mean yield of the trial in which they occurred.

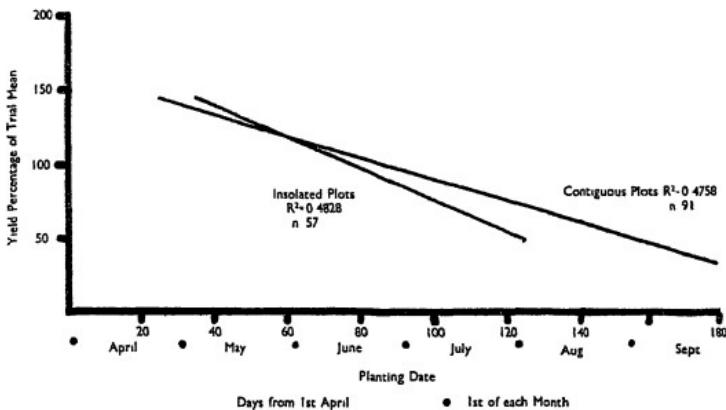
## Planting Date Trials

Date of planting was included as a treatment in twenty-nine trials conducted at Serere during the period 1925-46. These trials may be

divided into two groups. First, those experiments in which cotton planted on different dates was grown in contiguous plots. It has been argued that in experiments of this design the build-up of insects and diseases on the first planting subjects subsequent plantings to a higher infestation than normal and consequently reduces their yields. The second group of trials was so designed that individual plantings were isolated from each other and interference between plots planted at different dates was impossible.

In Fig. 1 the relationship between planting date and yield in both types of trial is diagrammatically represented. In the contiguous plot trials the treatment means have been expressed as a percentage of the trial mean in which they occurred; while in the less numerous isolated plot experiments the individual plot yields are expressed as a percentage of the trial mean. The linear relationship between yield and planting date is

Figure 1 Planting Date Trials Serere, 1925-48

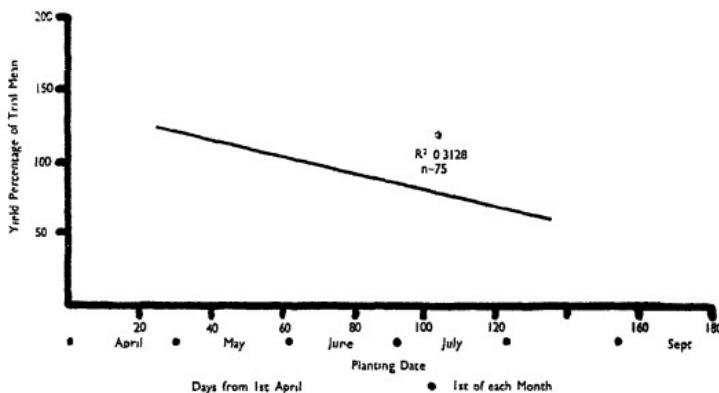


highly significant in both cases and there was no indication of a quadratic effect. The regression lines indicate that the contiguous plots have overestimated rather than underestimated the yield of the later plantings. Manning (1949) has reported similar results obtained from a planting date experiment conducted at Kawanda in 1946-47. He found that in a series of isolated groups of three plots, planted contiguously and on different dates, the earlier planting was more heavily attacked by *Lygus*. At Serere crop loss due to insects and disease is predominantly attributable to *Lygus* spp.

Additional evidence, derived from bulk plantings of cotton on Serere farm, is also presented in Fig. 2. The yields of individual fields are expressed as percentages of the mean seasonal yield for the whole farm. In the majority of cases the fields may be regarded as being grown in isolation from each other. Again the linear relationship is highly significant and there is no suggestion of a quadratic effect.

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Figure 2 Yield of Seed Cotton and Planting Date Serere Farm 1934-55



It is now possible to consider the contiguous plot planting date trials which have been conducted in other parts of the Northern and Eastern Provinces. In Fig. 3 data from four trials in Usuku County, three in Southern Busoga District, four in Bukedi District and nine trials at Ngetta are presented together with the Serere contiguous plot results. In all cases the relationship between yield and planting date is linear. In Table 1 the  $b$  values from the regression equations applicable to the various areas are listed together with the theoretical percentage yield lost by a delay in planting of one month.

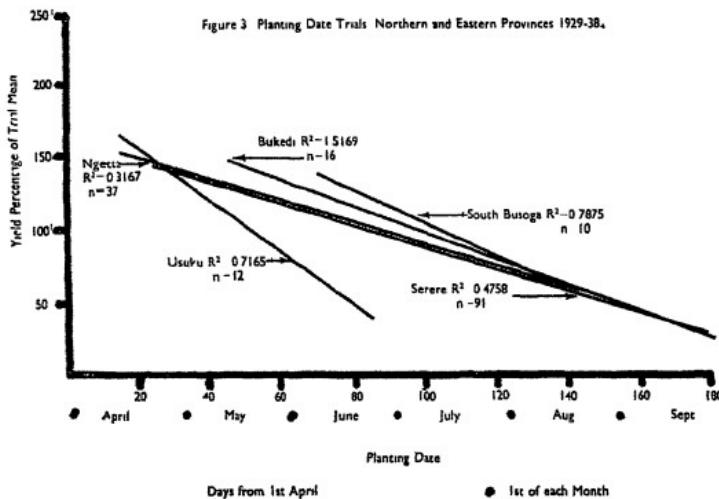


TABLE 1.—PLANTING DATE AND YIELD, NORTHERN AND EASTERN PROVINCES, UGANDA

Districts	<i>b</i>	Percentage yield lost due to a delay of one month in planting		
		April 16-May 16	May 16-June 15	June 15-Jul. 14
Usuku County ..	-0.4777	26	36	55
Southern Busoga ..	-0.3750	—	—	29
Bukedi District ..	-0.2887	—	18	21
Ngetta ..	-0.2453	15	17	20
Serere ..	-0.2447	—	17	20

In Usuku County, delay in planting caused the heaviest losses, one month's delay costing a quarter of the yield around April and May, and more than half the yield around June and July. In other areas, similar delays reduced the yield by 15 to 20 per cent.

Jameson (1954) has given evidence, derived from district production data, for the view that the variety S47 which is now in cultivation gives higher yields when planted between mid-June and mid-July than when planted before mid-June, whereas with N17, which was formerly grown in the Northern and Eastern Provinces, there is little difference between sowing dates in the yield obtained. Numerous varieties, including U4, SG29, N17, BP50 and their derivatives, were used in the trials under consideration and gave no indication of a variety  $\times$  sowing date interaction. S47 was not, however, included. Though there was no evidence in these trials that the optimum sowing date had been reached, there must be an optimum, and the possibility that the optimum may vary with the variety used must be considered. Further trials are planned to determine the optimum date for current varieties, and also to elucidate the variety  $\times$  sowing date interaction.

### Plant Population and Spacing

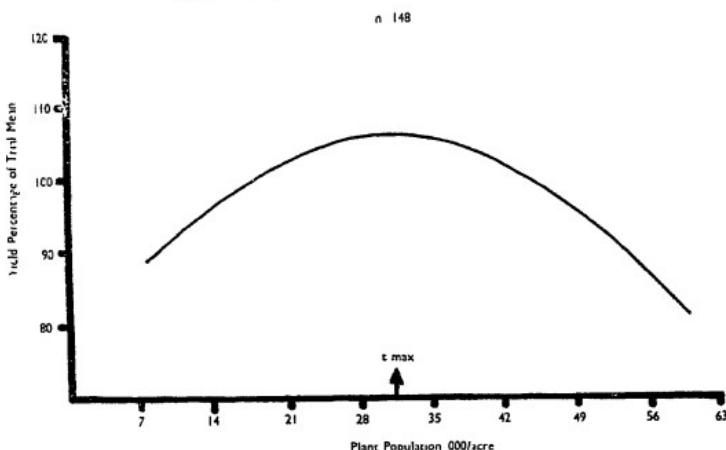
The results of 57 spacing trials conducted in the two Provinces during the period 1925-40 are presented in Table 2 and Fig. 4.

The relationship between yield and plant population is quadratic with an optimum plant population of 31,500 plants per acre (about  $3 \times 1$  ft. spacing with two plants per hole). The effect of plant population on yield was small (4 per cent. decrease) within the range 21,000 to 42,000

TABLE 2.—PERCENTAGE YIELDS FOR BETWEEN AND WITHIN ROW SPACINGS

Between row spacings	Within row spacings			
	2 ft.	1½ ft.	1 ft.	
4 ft.	% Yield	100	102	105
	Plant population per acre	10,890	14,520	21,780
3 ft.	% Yield	113	115	117
	Plant population per acre	14,520	19,360	29,040

Figure 4 Plant Population and Yield Northern and Eastern Provinces 1925-39



plants per acre. Inter-row differences had a greater effect on yield than differences in spacing within the rows. Of the two spacings  $4 \times 1\frac{1}{2}$  ft. and  $3 \times 2$  ft. (both giving a plant population of 14,520 plants per acre), the  $3 \times 2$  spacing gave the higher yield. The improvement in yield due to two plants per hole as against one plant per hole was small (Table 3) and in the case of the closer spacing ( $3 \times 1$  ft.) almost negligible.

TABLE 3.—PERCENTAGE YIELDS FOR SPACINGS WITH ONE AND TWO PLANTS PER HOLE

Spacing ft.					<i>One plant per hole</i>	<i>Two plants per hole</i>
$4 \times 2$	..	..	..	..	100	103
$3 \times 2$	..	..	..	..	112	115
$3 \times 1$	..	..	..	..	117	118

### Ridging Trials

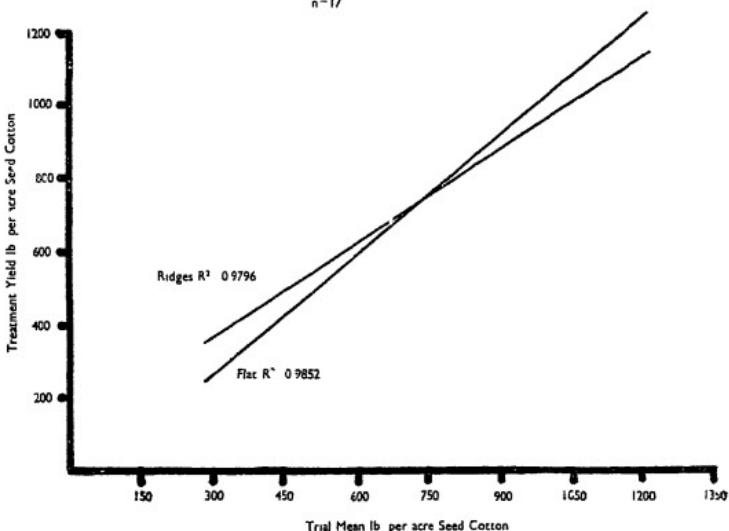
Results from two groups of trials which included ridged cultivations were available. One group was conducted between 1926 and 1934, while the more recent trials were carried out between 1954 and 1956. In order to consider the effect of ridging over the whole range of fertility levels at which the trials were conducted the regression of the treatment yield (ridge or flat) on the trial mean was calculated. The difference in the slopes of the two regression lines, which are presented in Fig. 5, is significant ( $P = <0.001$ ). At the lower fertility levels ridging had a beneficial effect, while at higher fertility levels the yield was depressed.

### Miscellaneous

A series of experiments on the effect of the date of opening the land from a grass ley on the yield of the subsequent cotton crop have been

Figure 5 Ridge and Flat Trials Eastern Province

n = 17



conducted at Nebbi, Kitgum and Aduku in the Northern Province during the three planting seasons 1953-55. Treatments involved opening the land eight weeks, five weeks, three weeks and one week before planting. All plots were planted on the same day, which in most experiments was in mid-July. None of the experiments, either individually or when analysed as a series, gave significant differences.

Other experiments include a subsoiling trial at Serere (1930-31), in which this treatment was shown to give yields of cotton superior to those obtained after ordinary ploughing methods. Mulching improved yield in a trial also carried out in Serere (1929-30), while mechanical cultivation was shown to give cotton yields higher than those obtained by hand cultivation at Serere (1925-26).

### Conclusions

The comparison of isolated planting date trials with those in which contiguous plots were used indicates that in the contiguous plot experiments there was no danger of interference between plots reducing the yields of the later plantings. Actually, late plantings yielded rather better in contiguous plot experiments than in isolated plot experiments.

Data from contiguous plot experiments in certain districts of the Northern and Eastern Provinces have been presented and a linear relationship between planting date and yield has been demonstrated. Plantings in April and early May are not, however, numerous, and an investigation of March, April and early May plantings may be expected to reveal departures from the linear relationship.

Plant populations had a small effect on yield over the range studied. The importance of considering row spacings as well as plant population has also been demonstrated. That results obtained from trials grown in experiment stations (where, for convenience in taking counts, only one plant is grown per hole, can be confidently interpreted in terms of district practice (where two plants are grown per hole) has also been demonstrated.

The date of opening trials conducted in the Northern Province might well give more informative results if the planting date of the cotton, which in the past was usually in July, was considerably earlier (April or early May) and the opening operations were proportionately advanced.

#### Acknowledgments

The data used in this paper were derived from trials conducted by the staff of the Department of Agriculture, Uganda. Acknowledgment is made to the Director of Agriculture for making the data available and for permission to publish the results. I am indebted to Mr. P. W. Taylor, Farm Manager, Serere, who provided the yield data from the Serere Farm cotton crops. To Sir Joseph Hutchinson I am indebted for his interest and help in the preparation of this paper.

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*Received July 1957.*

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**PRESENT PRACTICE IN THE TREATMENT OF  
COTTON SEED AGAINST BACTERIAL BLIGHT**  
**(*XANTHOMONAS MALVACEARUM*)**  
**(E. F. SMITH) DOWSON)**

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THIS note, supplementing an earlier article on cotton seed treatment,<sup>1</sup> summarizes and discusses replies to a questionnaire sent by the Empire Cotton Growing Corporation at the original suggestion of Mr. H. E. King to a number of territories in which Corporation staff are working, namely Aden Protectorate, Kenya, N. Nigeria, Nyasaland, the Republic of the Sudan, Tanganyika (Lake Province), Uganda and West Indies.

For convenience in presentation, the territories are divided into two groups: those employing copper (cuprous oxide) seed dressings, and those using mercury preparations. Some data for the first group are summarized in Table 1.

Bacterial blight has not yet been recorded in Aden, and seed dressing is applied there purely as a precautionary measure. In this and in the

TABLE 1.—DATA FROM TERRITORIES EMPLOYING CUPROUS OXIDE SEED DRESSINGS

Type of seed ..	Aden	Kenya	Nyasaland	Tanganyika	Uganda
	<i>barbadense</i> delinted	<i>hiisutum</i> fully fuzzed	<i>hiisutum</i> some machine- delinted, some fully fuzzed	<i>hiisutum</i> fully fuzzed	<i>hiisutum</i> some machine- delinted, some fully fuzzed.
Rate of application w/w .. ..	1 : 300	1 : 150	1 : 200	1 : 250	1 : 300
Method of application .. ..		B	A	A	A
Output (approx.) per machine ..	—	10 tons per 8 hr. shift	12 tons per day (one shift)	30 cwt. per hr. (large drums) 17 cwt. per hr. (small drums)	20 tons per day.
Quantity treated per annum (approx.)	300 tons	1,200 tons	1,000 tons†	6,500 tons	21,000 tons
Cost per ton of seed treated (approx.) (Sh.) .. ..	33s.	70s.	41s.	50s.	50s.

\* Mixing is by manual shovelling on a concrete floor combined with sunning of the seed for pink bollworm control.

A Intermittent-output revolving drum mixers.

B Continuous-output machines.

† For Lower River. Quantity for Central Province not given.

method of seed treatment Aden constitutes a special case, and beyond noting that a change to machine application of mercury seed dressing is envisaged, procedure there will not further be discussed.

In other territories, in all of which part or all of the seed dressed is fully fuzzed, rates of application vary from 1 : 150 to 1 : 300.\* Experimentation in Uganda has shown that the 1 : 300 rate, if thoroughly and accurately applied, may give results nearly equal to those from application at 1 : 150. This has been taken to justify the saving in cost from application of the lower rate in general practice. But in our current season's experiments, application of Perenox at 1 : 300 has given, *under the conditions most conducive to infection*, much poorer control of primary bacterial blight than 1 : 150, although the treatments, in small-scale experimental lots, were very thoroughly applied. When one considers also the inevitable inaccuracies in large-scale application, and the likelihood of occasional failure to obtain adequate coverage especially of seed carrying unduly large quantities of loose lint, the range of incidence of primary infection from seed treated with Percot at 1 : 300 quoted in my earlier article<sup>1</sup> is hardly surprising. No doubt with these considerations in mind, rates of application in Uganda are to be increased to 1 : 250 for BP52, and 1 : 200 for the more heavily fuzzed S47 (that also is grown in areas where bacterial blight tends to be more severe).

The larger part of the cost of seed treatment is in the cost of the bactericide itself. Doubling the rate of application in Uganda, from 1 : 300 to 1 : 150, would cost about £28,000. Such an additional expenditure would not, quite properly, be undertaken lightly. But to view it outside its context exaggerates its real magnitude. Allowing, as has been allowed in Uganda, 40 lb. of treated seed per acre planted, 21,000 tons of seed will plant 1,176,000 acres at a cost of £50,000 for the seed treatment, or rather less than one shilling per acre. Doubling the rate of application would add about 50 cents (6d.) per acre. In the former case an increase in yield of only 2 lb. seed cotton per acre, and in the latter of only 3 lb., would fully cover the costs of the treatment. Accurate estimation of loss of crop due to bacterial blight, and of reduction of this loss by seed treatment, is technically very difficult. While there can be little doubt that some past claims are exaggerated, more recent evidence does indicate that gains much greater than 2 or 3 lb. seed cotton per acre can confidently be expected from seed treatment.

Before leaving the question of cost there is another pertinent aspect to consider. In Uganda, to produce in a favourable year a good average crop of 350,000 bales, about 21,000 tons of seed is treated for planting; or, put in another way, 1 lb. of seed is treated to produce about 10 lb. of seed cotton. Much more seed is treated than is really necessary. Increasing recognition (which could well be stimulated) of the value of treated planting seed, improved organization of distribution, and continued propaganda against excessive planting rates (in itself also a valuable contribution to reduction in primary infection, since halving the

\* All of these except Kenya use Percot, a cuprous oxide preparation formulated for seed dressing. Kenya contemplates adopting Percot also, in place of the essentially similar Perenox (cuprous oxide formulated for foliage spraying) hitherto employed.

seed rate means halving the number of disease foci per acre, could reduce the already low costs of seed treatment, or offset the possibly higher cost of more efficient methods.

The efficiency of cuprous oxide seed dressing in controlling bacterial blight was extensively discussed in my earlier article.<sup>1</sup> For convenience the concluding paragraph is now quoted: "From these data, it is clearly apparent that while cuprous oxide seed dressing has materially reduced primary infection in Uganda, it has not reduced it below levels from which considerable secondary infection can develop. It has been reported also from the Lake Province of Tanganyika that the same seed dressing, although generally resulting in marked control of early main stem attack, has not materially lessened the commonly high incidence of bacterial boll disease, and in Nyasaland in 1955-56 season there was a severe attack of bacterial blight, especially of boll disease, in crops planted from cuprous oxide treated seed." Experience in Kenya has been similar. Conventionally designed field trials to determine the influence of seed treatment on yield tend to give inconclusive results, because of spread of infection from the untreated seed plots into those planted with treated seed. Nevertheless, some of the trials of this type by M. H. Arnold in Tanganyika<sup>2, 3</sup> have given significant yield increases from seed treatment with cuprous oxide, of the order of 150-200 lb. seed cotton per acre. No estimates of this order of reliability are available from other territories.

In the three territories in which mercury compounds are used on a commercial scale, Sudan, N. Nigeria and West Indies (St. Vincent), materials and methods differ rather widely. In Sudan, the tufted *barbadense* seed is treated with Abavit B powder (a mercuric chloride-iodide mixture), in continuous-output Simon mixer and heater machines, at 1 : 150 or 1 : 175 according to the level of infection in the areas from which the seed is drawn. In N. Nigeria, fully fuzzed *hisutum* seed is dusted with the organic mercurial compound Agrosan GN5, at 1 : 150, in an intermittent-output revolving drum mixer. So far, only seed for multiplication areas, 300-400 tons per annum, has been commercially treated. In St. Vincent, tufted *barbadense* seed is treated by immersion for half an hour in a 1 : 1,000 solution of mercuric chloride, in batches of 1,200 lb. in an outdoor concrete cistern. After treatment the seed is dried and hand-cleaned.

No figures for cost have been given, except for N. Nigeria, where the cost of the treatment with the previously employed hand churrs was about 90 shillings per ton. Cost with the new power-driven machine is expected to be about the same.

Many comparative trials of copper and mercury seed dressings in Nigeria, Sudan, Tanganyika and Uganda provide abundant evidence of the superiority of the latter in reducing primary infection of bacterial blight. Simple arithmetical computation shows that if 11·1 per cent. of primary infection foci are evenly distributed, then every plant is either infected or immediately adjacent to an infected plant. With 1 per cent. primary infection, uniformly distributed in a field planted at 3 feet by 1 foot spacing, no plant is further than about 4 yards from an infection focus. Primary infection rates from cuprous oxide treated seed commonly

fall about midway between these levels. It is hardly surprising therefore that this form of treatment has often had apparently little effect on secondary development of the disease.

It therefore remains to consider whether it is likely that practicable and economic means can be found of reducing primary infection to such low levels that secondary infection is also considerably reduced. Mercury seed dressings, the most effective commercially applicable yet found,\* have admittedly failed in some seasons in the Sudan Gezira to prevent severe epidemics. It has however to be remembered that in the Gezira conditions can be particularly favourable climatically to epidemic spread of bacterial blight, in large areas of a highly susceptible variety. At Namulunge, at the other end of the scale of likelihood of severe primary or secondary infection developing (excluding of course Aden, where bacterial blight has not yet been recorded), a high degree of control of bacterial blight in all its phases has commonly been achieved by mercury seed dressings.

In some quarters in some territories, objections to the use of mercury, mainly on the grounds of danger to operatives at seed dressing stations and of possible misuse of the treated seed, persist. These are valid theoretical objections, but perhaps difficult to uphold against decades of experience in Sudan, supported by some years of experience in Nigeria and St. Vincent. The promise of mercurial seed dressings calls for extensive trials of their practicability and effectiveness in territories now using copper dressings (large-scale tests are already projected in Tanganyika), against the time when it may be generally agreed that levels of organization, skill and probity are adequate to give the same likelihood of freedom from mishap as has been experienced in those territories that have for years used mercury compounds. In Uganda, the efficiency and practicability of liquid applications of mercury are being studied, as a means of obviating possible hazards in the process of commercial-scale dust treatment.

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*Received November 1957.*

\* Sulphuric acid delinting is not regarded as commercially applicable in the territories with which we are concerned.

## THE SPRAYING AND DUSTING OF COTTON IN EAST AFRICA

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DURING the summer of 1956 the author visited three territories in East Africa to study the methods in use for the application of pesticides and the conditions under which they have to be used. The visit was made under the auspices of the Colonial Office with a view to gathering information for the improvement of existing equipment and the development of better machines to meet problems in overseas and tropical countries. Every facility was provided so that as much as possible could be seen in the time available. Especial thanks must be given to the Empire Cotton Growing Corporation and to the various members of their staff in East Africa for all the information and assistance so generously provided.

It must be appreciated from the outset that it was impossible to form more than generalised impressions from such a trip and that there can be no attempt to dogmatize about the types of spraying or dusting equipment for use in East Africa in any particular crop. Furthermore, although as much time as possible was devoted to problems in relation to cotton, owing to its importance as a cash crop, the programme included the application of pesticides over a wide field; namely, agricultural, stored products, public health, veterinary and forestry control. Variation in the conditions of climate, soils, economics, etc., are sufficiently well known to show that, whereas certain equipment and methods may be perfectly satisfactory in one place, they may be quite unsuitable in even an adjacent district. Therefore it is intended that this paper refers only to those places actually visited, although many of the observations may apply elsewhere.

### Major Considerations

Three major considerations emerged at quite an early stage of the trip. Firstly, the use of chemical control of pests and diseases is of course closely related to the economics of the crop in question. In the agricultural field it frequently appeared that the application of chemical control would be quite uneconomic owing to the poor cultivation of the crop. All too often an improvement in cultivation would have resulted in a greater yield than could have been obtained by any form of plant protection. All this is, of course, well known and although efforts are being made to improve matters the task is not an easy one. Vast areas are concerned and, as a visitor, I was impressed by the amount of work spread over such very great distances which is apparently being carried on by so few people. It is neither the purpose nor the intention of this paper to discuss the various aspects of chemical control, but it is assumed that pesticides are to be used and that the choice of equipment is the main consideration.

Secondly, it is of the utmost importance that if spraying or dusting

equipment is to be used it must be of the right type. A great deal of time was expended during the visit in giving technical advice on the use and operation of existing machines or supplying information regarding alternative equipment and recent modifications. This lack of technical service appears to be one of the biggest drawbacks in the use of spraying and dusting machinery in East Africa at present. On more than one occasion I saw machines which had been purchased for a specific purpose which were subsequently found to be totally unsuitable. On the other hand, machines which were quite suitable for the purpose intended had been abandoned, in some instances as the result of lack of information and knowledge of their proper use.

The third consideration, that of maintenance and repair, is a universal problem in East Africa and by no means confined to spraying and dusting machinery. Generally speaking, spare parts are not available locally and although agents will order spare parts from the United Kingdom, they are very loath to carry any stocks on the grounds that new models or modifications are continually being introduced, so that if spare parts are ordered, invariably, as the result of the lack of up-to-date information, the wrong items are received. Some agents will undertake simple repairs to machines which they have sold, but it is more usual to find that their interest ceases with the sale of the equipment. Delays in shipment from the United Kingdom are notorious and considerable distances may still have to be covered even when the required parts have reached a port in East Africa. Other than in the larger towns, repair facilities are limited to the local Asian metal worker or garage, where work of only the most elementary kind can be undertaken. If, therefore, equipment other than the simplest hand-operated types is contemplated, provision must be made for adequate maintenance and repair. This need not entail equipping a large workshop, but it is essential that at least a basic toolbox is available containing spanners and screwdrivers of the right size, an assortment of small punches, allen keys, grips, etc., as well as a bench and attached vice on which the work can be carried out. The usual method of attempting to use an adjustable spanner, a large pair of pliers or a stilson wrench and a screwdriver with a half-inch blade inevitably leads to disaster. Most of the manufacturers of spraying and dusting equipment provide a simple tool kit for use with their equipment, but this is in no way intended to enable the user to do more than carry out simple adjustments in the field. They will usually readily suggest a list of tools and sizes required if asked to do so and if the circumstances under which the equipment is to be used is explained to them.

### Dusting versus Spraying

When deciding on what application equipment is to be used, consideration should be given to whether it is better to dust or to spray. The use of a dust has great advantage over spraying in that the problem of water supply does not arise and the chance of phytotoxic damage is generally thought to be less. On the other hand, it is cheaper and often far more practical to transport concentrated spray materials than large bulks of dust. The application of dust is usually limited to those periods

when favourable meteorological conditions prevail, mainly early in the morning or late in the evening, the morning probably being more suitable when foliage is still damp with dew and the dust has the best chance of adhering. Furthermore, the onset of the attack by pests, and therefore the need for chemical control, frequently coincides with the rainy season and dusts are rapidly removed by tropical rain. As a result, it often happens that both time and materials are lost and a further application has to be made. It can be argued, of course, that the rain will tend to wash the pesticide down into inaccessible parts of the plant, which may be of advantage in controlling certain kinds of pest, but this is of little value where a good overall residual cover is required.

In addition to rain, the action of wind has to be considered. This is especially important in a dense crop where much of the dust is rapidly removed by abrasion as the foliage and individual plants rub and knock against each other.

Probably one of the main disadvantages in the use of dusts in the tropics is the question of storage, as usually it is not possible to purchase small amounts. Moisture is taken up very rapidly by most dusts, with the result that application becomes very difficult if not impossible. To some extent this can be overcome if the dust can be supplied broken down in small amounts in sealed plastic bags to hold roughly the required amount to fill the container of the machine to be used. A bulk supply of material in this form can be opened and used as needed without any serious deterioration if some remains unused for a period. It also enables the right amount of dust for a given area to be quickly dispensed from the store and, as long as the plastic bag remains intact, ensures its arrival in a dry condition in the field.

### Dusting

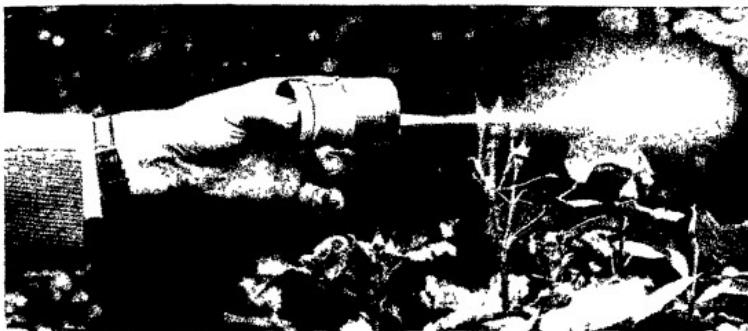
Many of these disadvantages can be outweighed by the fact that very simple application equipment can be used and, generally speaking, dusting machines are cheaper than spraying machines. Where small areas are to be treated under peasant farming conditions, the calico or muslin bag and the simple tin with holes pierced in the lid can be used with a certain success at hardly any cost. Something better than such a random application is usually required, however, as it is often important to get the dust on the under surface of the foliage. Equipment which will give a directional discharge of the dust, such as the simple applicator devised by Mr. G. Swaine, one of the Government Entomologists in Tanganyika, or the small puffer type of applicator, gives quite good results. They are only really suitable where small areas have to be dealt with, and the puffer type applicator is probably most suitable for young cotton or small bushes.

For larger areas, exceeding an acre or so, a greater output of dust is normally required and the hand-operated rotary duster appears to be the best solution. These machines are generally severely criticized on the grounds that they are unreliable because the dust packs in the container or clogs the feeding mechanism. Much of this trouble, as has been discussed, is due to the use of damp material or to the entry of moisture

into the dusting machine itself. In addition, it should be appreciated that a wide range of fillers or diluents are used in formulating dusts and these have, in turn, a wide range of densities. For this reason it will be obvious that a given machine will often give a better performance with one particular kind of material. It is also a great advantage to use the type of machine in which the dust flow is vertical from the container through the feeding mechanism directly into the intake of the blower. This obviates the use of a worm device to change the direction of flow of dust from vertical to horizontal in order to get it to the intake of the blower via a small aperture which can be varied in size to control the output. Such a device usually provides too many opportunities for the dust to pack and clog before reaching the blower intake. Also, dusters employing this principle usually have some device to keep the dust continually stirred to try to prevent packing. This means that two separate drives have to be taken from the gears operated by the handle, often making these machines heavy and tiring to operate. In many instances unless the hand-operated rotary duster of this type can be operated when empty by turning the handle by means of one finger, it will be found too fatiguing to use for continuous periods of half an hour or more. Much of the criticism of rotary dusters, such as the fact that they are easily damaged by overzealous operation, or that the carrying straps or harness cause discomfort, is due to this unnecessary effort required to turn the operating handle. Another small point is that many people find a large knob-shaped handle preferable to the more conventional trowel-shaped handle. This can be grasped in the hand with the thumb uppermost instead of the knuckles being uppermost, thus relieving the wrist of flexing movements during operation of the machine.

Where a machine is required to give a greater output than can be obtained by the hand-operated rotary duster, the knapsack power-operated duster or the stretcher-carried version might be used. These are operated by a small two-stroke petrol engine, between 50 and 100 c.c. in capacity, and all the old troubles associated with two-stroke engines have been overcome in recent years, especially by Continental engine manufacturers. Although the use of an engine overcomes the fatigue of operation, the machine has still to be carried, and when working on rough terrain the weight of these machines (anything from about 40 to 60 lb. for the knapsack type) can be very tiring. The stretcher or pole-carried machines are even heavier, but the load is distributed between two people and the weight is generally taken on webbing harness worn over the shoulders, leaving the hands free to guide the machine through the crop. The African varies greatly in physique and his ability to carry loads on the back. Although, generally speaking, they are small and light in build, many are tough and wiry and are not unduly distressed when using machines weighing 50 lb. or more for periods up to an hour. Others, however, may find much lighter weights far too fatiguing over even shorter intervals. When using either type of machine, the most satisfactory arrangement is to have relays available so that the operator alternates between actual application of the dust and some other task in connection with it, such as acting as a marker or refilling the machines as they empty.

PLATE I



*Photograph by "Machinery"*

*Above: A SIMPLE APPLICATOR OF THE PUFFER TYPE FOR USE WITH DUSTS.*



*Left: A WHEELBARROW ELECTROSTATIC DUSTING MACHINE IN USE SHOWING THE TENDENCY FOR THE DUST TO HANG IN THE FOLIAGE*

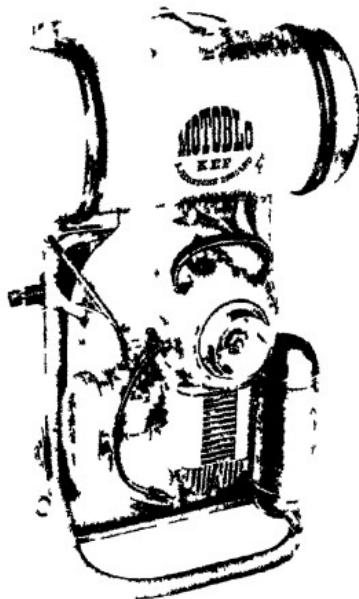
*Below: A STRETCHER CARRIED ELECTROSTATIC DUSTING MACHINE SHOWING THE POSITION OF THE PROBE IN THE DUST DISCHARGE TUBE.*

*Photograph by Metallurgical Chemists Ltd.*



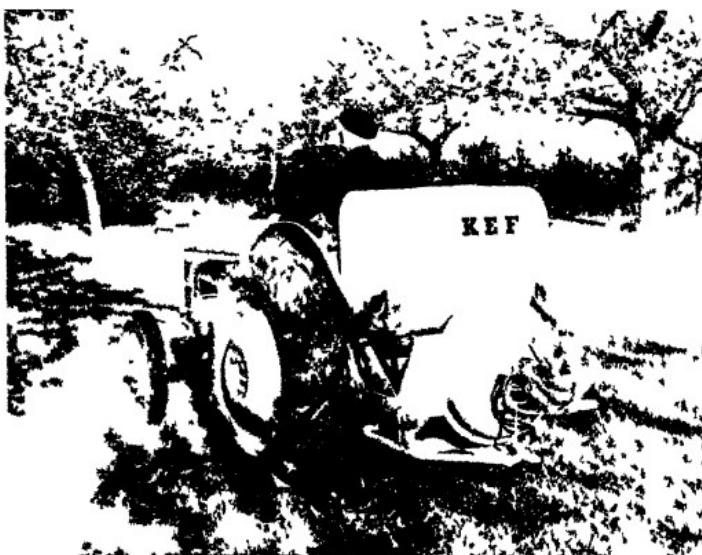
*Photograph by Metallurgical Chemists Ltd.*

PLATE II



*This model has been developed*

A MOTORISED KNAPSACK SPRAYER FITTED WITH A 98 cc TWO STROKE PETROL ENGINE



*This model has been developed*

A TRACTOR MOUNTED LOW VOLUME MISTBLOWE OPERATED FROM THE POWER TAKE OFF SHOWING THE FINE NOZZLE ARRAY

### **Electrodusting**

A recent development in the application of dusts is the introduction of the technique of electrostatic precipitation or electrodusting. The necessary electrical components, consisting basically of a generator or other primary power source, special transformer and discharge probe, are fitted to either a conventional knapsack power-operated duster or the stretcher-carried version. As the dust leaves the discharge outlet it passes through an ionised field created by a coronal type of electric discharge which takes place between a central probe and the metal dust discharge tube. A positive charge is thus imparted to the dust particles as they are blown out. This results in giving a good dispersion to the dust cloud, and greatly increasing both the amount of the deposit and the uniformity of it on the plant foliage. In addition, as the charged dust particles tend to follow the lines of electrostatic force, they are deposited on all surfaces irrespective of the fact that they may face towards or away from the direction of the dust discharge. Not only is excellent underleaf cover and penetration into the foliage obtained, but there is a very marked improvement in the adhesion of the dust. This is thought to be due to the fact that electrochemical forces are involved in holding the dust particles to the leaf surface, and experiments recently carried out have shown that dusts applied to foliage by this method have withstood the action of both wind and rain considerably better than dusts applied by the normal impaction method. A natural comment made about this method is that any device involving high voltage discharge can be very dangerous to have attached to the body, but in fact, although the voltage is high (15,000 to 20,000 volts), the current flowing at any time is negligible. Even though inadvertently a shock may be received, it is certainly not in any way dangerous and less so than one resulting from the coil ignition system on a car.

### **High and Low Volume Spraying**

In contrast to dusting, it was found that great interest was centred in the use of low volume spraying in the agricultural field, including its use for cotton. In the vast majority of places high volume spraying as recognized in the United Kingdom would be quite impossible owing to the difficulty of water supply. Even though this factor could be ruled out in some way, it is not generally appreciated that it would still be impossible to use high volume spraying in many places because of the size and weight of the machinery involved. Low volume spraying of the order of 4 to 12 gallons to the acre appears to be possible in many places and seems to be the most profitable use of chemical control. As far as is known, concentrate spraying has not yet been tried out in agricultural crops in East Africa and it may well be that some time will elapse before all the difficulties of phytotoxicity can be overcome. The great advantage that low volume sprays have over dusts, especially in the tropics, is that once the deposit has had time to dry off it will withstand the action of rain and wind very much better than dust applications, and therefore it is frequently possible to make application in the all-important rainy season with some measure of success.

### **Hand-Operated Sprayers**

Quite a lot of low volume spraying was seen in all fields of control work, mainly with knapsack equipment, but surprisingly enough fairly often with hand-operated sprayers. In peasant agriculture it was abundantly obvious that the cost of the application equipment was the overriding factor in the use of sprays. Where the cash return of the crop may only amount to £5 or £10 per acre it is quite incongruous to suggest the purchase of equipment costing more than 25s. to 30s. for scattered field plots only  $\frac{1}{3}$ -1 acre in area. For this reason hand sprayers have often been used as they can be purchased within this figure. The more satisfactory equipment is either the lever-operated knapsack or the compression type of sprayer, costing anything from £10 to £25. For many years very little alternative existed between these two price ranges, with the exception of sprayers such as bucket pumps, which are not entirely satisfactory for a crop like cotton. It therefore seemed that use could be made of the self-supplying syringe type of sprayer and a locally obtained container which could be either shoulder slung or shoulder mounted. This sort of equipment is now available from some manufacturers. Two kinds of self-supplying syringe or hand pump are employed, namely a plunger-operated pump specially designed to give a continuous spray, or a simple trombone type pump incorporating a small air chamber, again to ensure continuous spray. These are obtainable at about 30s. and can be bought from one manufacturer with a choice of nozzle, to give an adjustable spray which can be varied from fine to coarse for a range of distances or a plain jet of up to 20 ft. or more, or can be fitted with a fan jet. They can also be supplied with an inexpensive shoulder-slung container especially treated to withstand corrosion.

The other types of knapsack sprayer in use can be broadly classified into three groups, namely hand-operated, compression types and motorized. For agricultural work the hand-operated knapsack, in which the operating lever is mounted so that it comes over the shoulder, seems to be the most suitable for use by the African. These hand-operated machines are generally lighter than other types and very little instruction is required for their use. As manufactured, these sprayers are worked by pulling on a trowel-type handle which is attached to the lever by a rod some 14-18 inches long. For use by the African it has been found better to replace this with a cross-handle grip on about a 6-inch rod and to attach the handle so that it is free to rotate on the rod and thus be held at any angle comfortable to the operator. The best thickness to use for this handle seems to be about 1 inch diameter. When using low volume nozzles, whether made of ceramic or carbide insert or metal, a few quick pulls on the operating handle rapidly build up spraying pressure which can thereafter easily be maintained by one or two pulls at intervals as the pressure starts to fall off. This method of operation seems to be much easier for an African to become accustomed to, rather than attempting to get even continuous pumping as is necessary with the more usual hand-operated knapsack sprayer where the lever is placed at waist level.

### Compression Sprayers

Where larger areas have to be dealt with under supervision by European staff the compression type sprayer is often favoured, as once it has been charged it enables the operator to concentrate on the application of the spray. The old criticism of this type of sprayer was that it would not discharge the whole contents without a serious fall-off in pressure unless repumped and, furthermore, any air pressure retained at the end was lost when the sprayer required refilling. This has been completely overcome by the pressure-retaining knapsack sprayer, as only one initial air charge per day has to be made which is sufficient to empty the container completely. When refilling, the air is retained and compressed once more by the introduction of the liquid by means of a simple hand-operated hydraulic pump, which is far quicker and easier than pumping up the air space in the sprayer to a pressure of about 75 lb. per square inch on each occasion. A further advantage of this sprayer, when used in the field, is that the filling of the liquid through a suction hose is easier and cleaner than trying to pour 2 gallons of liquid from a debe can through a hole only  $1\frac{1}{2}$  inches in diameter. In this connection, the manufacturer usually pleads that a special funnel is provided for filling, but fails to appreciate that this is the first item to be either lost or appropriated for some other purpose. Additional advantages of these pressure retaining sprayers are that they can also be fitted with a pressure reducing valve so that the complete contents of the machine can be discharged at a constant rate, and where required a number of these sprayers can be operated on a battery system charged at a selected point. For such a system, where six to eight or even more sprayers are in use, a lever-operated pump of larger capacity is used which saves considerable time. The simultaneous charging of six or more sprayers can also be carried out if a motor-driven pumping unit is employed. Some of these pressure retaining knapsack sprayers are considerably heavier than the hand-operated knapsacks and it is important to keep the weight down as much as possible. For this reason most of these sprayers have the charging pump detachable so that it is not carried when spraying. As has been mentioned previously, the value of this is somewhat debatable in that anything detachable is usually left behind, lost or misappropriated. Weight is also important in relation to the physique or weight-carrying capacity of the African and to the conditions of terrain concerned. It is important to remember that all knapsack sprayers have an unbalancing effect on the user which is especially noticeable when the container is only part full.

### Power-Operated Sprayers

The heaviest of the knapsack sprayers is, of course, the motorized version. Although very few of these were seen in use, trials were contemplated at various places and it was felt that there is quite a potential use for this type, particularly in agriculture. These are powered by the same engines as the knapsack power-operated dusting machines previously discussed. Basically these machines are all mistblowers—i.e., a fan or blower is used to convey droplets formed either by the air blast or, in one

example, by spinning discs. The rate of discharge can be kept reasonably constant with this machine, as most manufacturers supply a range of metering jets to control the liquid feed. In practice these machines have proved to be remarkably reliable, running for protracted periods without any serious trouble. Their great advantage is that they give a very good throw or projection of the spray (30 to 35 feet in calm conditions in one instance) and excellent penetration of foliage is therefore obtained. The early designs tended to give a rather narrow beam of spray, but this has been greatly improved latterly and double outlets can now be obtained to spread the spray or to cover two rows at a time, and these double outlets can also be inclined upwards to give under-leaf coverage. Owing to the absence of any agitation in the container of early machines difficulty was also experienced when using suspensions. One well-known make of this type of sprayer now provides a paddle agitator driven by the engine. The weight of these sprayers is frequently thought to be excessive for prolonged use, but by the provision of spare teams to work in relays, they can be kept in use throughout the day. In practice, one spare operator to three units gives adequate rest.

Very little use of tractor mounted or tractor trailed machinery was seen, only a few Agricultural or Experimental Stations having such equipment. The first difficulty is that the low clearance of these machines and the driving of tractors through densely and irregularly planted crops is considered likely to cause too much damage. These objections have been largely overcome by using guards and shields, but in many places wheeled tractors are impracticable owing to excessive slopes and the soil conditions. Again, the use of tractors is frequently precluded where ridging is carried out for the conservation of water or soil. Quite apart from any consideration of water supply, it is very important that the weight of these machines, especially the trailer machines, be kept to a minimum. Anything in excess of 200 gallons capacity is too liable to get bogged down, 100 to 150 gallons probably being the most satisfactory size.

The trailer type machine fitted with conventional row crop booms or with wide-angle nozzles has been used successfully in cotton where large acreages are involved on a plantation scale. It does seem however that the tractor mounted machine is likely to cause less damage to the crop, the main disadvantage being that it is more laborious to attach to or remove from the tractor. Small trailer type air blast machines were also seen, including one small version of 100 gallons capacity which had been specially designed in East Africa to meet agricultural problems. The use of these machines would, however, be limited to those places where there is an adequate water supply.

Of recent years, mistblowing has been given much prominence in the field of low volume spraying and some very great advances have been made in design. These machines have very low rates of application, down to 2 or 3 gallons per acre in some instances, the more usual rates being of the order of 30 to 50 gallons per acre. A recent introduction has been that of a tractor mounted machine with a 60 gallon tank and very similar nozzles to those used on the knapsack mistblowers. Either one large single outlet can be used or four or eight smaller ones which can be

positioned in any direction required and all are capable of being manually rotated by the tractor driver at any time to make allowance for wind. Other types of this machine are available, one of which can be used for concentrate spraying. Some tractor mounted machines in this category make use of spinning baskets in the air outlet resulting in very fine droplets and low outputs.

### Conclusion

In conclusion, it appeared that the view prevalent among those responsible for recommending the use of spraying and dusting machinery was that it is useless to put anything other than the most simple and robust equipment into the hands of the African. After all, it must be remembered that he has virtually no mechanical background; for example, neither he nor his children have ever possessed mechanical toys. Notwithstanding this, given a good basic training and under supervision, there should be no difficulty in initiating him into the correct use and care of such machines. In many places it was noticed that Africans are graduating from the pedal cycle to the motor-bicycle and that they are carrying out their own maintenance. Some remarkable feats of ingenuity and improvisation were seen, which enabled the owner to keep his machine running. Mechanization of agriculture in East Africa will not be accomplished quickly but will come gradually as the standard of living rises.

To an independent observer it would seem that the greatest difficulty is presented by the shortage of staff in the various departments concerned with the use of chemical control and its extension in the field, and especially of personnel possessing the necessary technical knowledge and mechanical ability to instruct and subsequently supervise. A point worth making is that the use and maintenance of spraying equipment is little different from the running and maintenance of a motor-car, and surely one can hope that in the near future the entomologists, botanists or agricultural officers will accept the direction of spraying operations and the use and maintenance of the equipment as part of their normal duties.

*Received November 1957.*

## PERENNIAL COTTON TYPES IN BRITISH GUIANA

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AN earlier article (*EMPIRE COTTON GROWING REVIEW*, October 1955) gave some account of the old perennial cotton crop in British Guiana. During my recent appointment there I made some study of the local surviving plants, which are found frequently on the coast. Although my examination of them was not very detailed, the few notes I was able to compile seem worth putting on record.

The main type used for hand spinning by the Amerindians of the interior is the green leaved Kidney. This was noted both with and without the red petal spot. It was never found on the coast, but was included in a collection of perennial types which I grew there, and from which a sample examined by Shirley Institute gave the following figures:

Effective length $\frac{1}{4}$ in. ..	..	..	..	41
Hair weight ..	..	..	..	269
Maturity ratio ..	..	..	..	1.075
Standard hair weight ..	..	..	..	250

Although this standard Kidney form was by far the biggest component of the interior village crops, a search revealed the following Kidney variants: (a) red leaved, (b) brown linted, (c) fuzzy seeded.

Several free-seeded forms having some general characteristics of the Kidney type were also found, and are presumably the hybrid forms referred to in "The Evolution of *Gossypium*" (Hutchinson, Silow and Stephens), page 51.

Among coastal garden plants only one *barbadense* type appeared, a strong-growing red leaved form with a coarse lint. No analysis was done on this, but it was judged in Liverpool as a useful hard cotton of about Ashmouni length. From the Empire Cotton Growing Corporation perennial type collection at Shambat I had four strains for trial, two of which unfortunately failed to germinate. The other two, under British Guiana conditions, were early fruiting and with growth more typical of annuals, showing nothing of the growth vigour of the local perennials. These four selections had been sent to me as high quality *barbadense*, possibly representing types with a similarity to the original Sea Island perennial parent. My corner of South America produced no *barbadenses* at all similar, either in growth or fibre quality.

Two introduced Marie Galante strains, the Moko cotton from North Brazil and the type at present grown in Carriacou, were compared with several plants of Marie Galante found on the coast. The first difference noted was that both these introductions were naked seeded, while all the local plants were fuzzy. The introductions were both also green leaved. Of the two, the Moko was a very much more vigorous grower than the Carriacou.

The numerous Marie Galante plants collected locally all fall into three type groups. There was first a green leaved form which appeared identical with the Carriacou in general growth characteristics, differing from it only in the seed fuzziness. Two other forms had purplish leaves. These two were similar in leaf and seed characters but differed in growth habit, boll and lint. The poorer linted form had small bolls, with very erect monopodia, giving an altogether different plant form from that of the better linted type, which had weaker and more spreading monopodia. This latter type showed attractive lint length, and a Shirley Institute analysis gave:

Effective length $\frac{1}{2}$ in. .. .. .. ..	48
Hair weight .. .. .. ..	122
Maturity ratio .. .. .. ..	0.83
Standard hair weight .. .. .. ..	147

Characteristic of this type was the boll which resembled much more a typical *barbadense* boll than a Marie Galante, and was predominantly three locked. This point of lock count and boll form may be of some relevance to the suggestion that high quality genes of *barbadense* were incorporated in the Marie Galante stock (E.C.G.C. Research Memoir No. 12, p. 189).

The two more interesting of my types were given, for future identification, names taken from the local rivers, the red leaved *barbadense* being called the Berbice type, and the high quality Marie Galante the Essequibo type.

*Received October 1957.*

# CRYPTIC TWIN PLANTS IN NEW WORLD COTTON

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THE occurrence of haploid-diploid twin embryos in *Gossypium* was first reported by Harland.<sup>1</sup> Cytological studies by Skovsted,<sup>2</sup> Beasley,<sup>3,4</sup> and Webber<sup>5</sup> showed that, where a conspicuous difference in size existed between the twin plants, the smaller member of the pair was nearly always a haploid (see Fig. 1A).

At this laboratory the appearance of twin radicles shortly after germination led to the detection of forty-seven sets of twin plants in *G. barbadense* (Sea Island cotton) and one in *G. hirsutum* (Upland cotton). Several plants died at the cotyledon stage; these included both diploids and haploids, as indicated by the relative size and position of the other member of the pair. However, mortality rates were very similar for both haploids and diploids (6 per cent. and 4 per cent. respectively).

The mortality rate in haploids might be expected to be higher than that in diploids, and it was considered that the method of twin detection used might not be revealing all the twins actually present in this material. A minute member of a twin pair might never progress as far as radicle emergence.

A detailed search was made in the strain V135 of Sea Island cotton, which was known to exhibit a high frequency of twins (0.36 per cent. of viable seeds). Three thousand seeds were soaked for twenty-four hours, placed on damp filter paper and the embryos ejected by pressure on the end of the seed coat at the splitting stage. The cotyledons usually expanded within the next two days. It was then seen that very small embryos (Fig. 1B) sometimes occurred in the folds of the cotyledon of the normal plant. These pairs may be referred to as "cryptic twins." Table 1 gives the numbers of normal and cryptic twins found in this sample of 3,000 seeds and the number of normal twins in 10,000 seeds of the same strain.

TABLE 1.—NUMBERS OF NORMAL AND CRYPTIC TWINS OBSERVED IN SEEDS OF SEA ISLAND V135 COTTON

						<i>Testa not removed</i>	<i>Testa removed</i>
Number of seeds examined	..	..	..	..	..	10,000	3,000
Per cent. germination	..	..	..	..	..	84.1	76.1
Number of normal twin pairs	..	..	..	..	..	30	9
Number of cryptic twin pairs	..	..	..	..	..	—	8
Total twins, as percentage viable seed	..	..	..	..	..	0.364	0.744

Upland cotton has a very low frequency of normal twins. Only two pairs have been found in 127,500 seeds, of which 81.7 per cent. germinated. It was, therefore, of interest to investigate the occurrence and frequency of cryptic twins in this variety. In a sample of 29,000

PLATE III

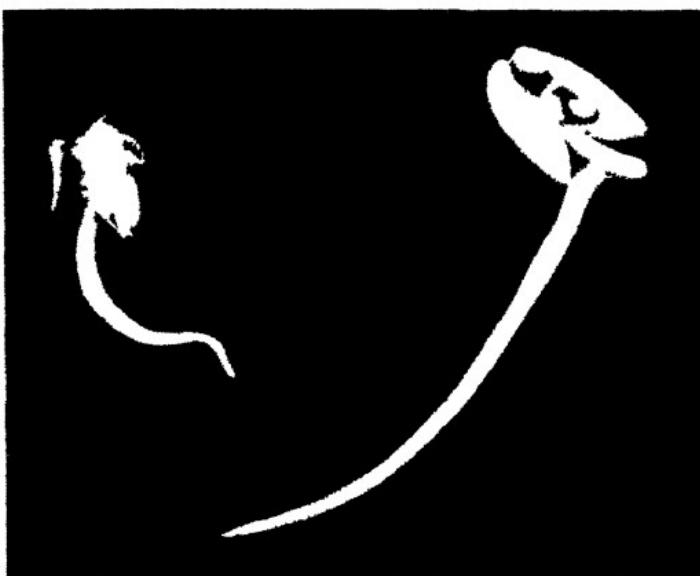


FIG. IA. A NORMAL HAPLOID-DIPLOID TWIN PAIR.



*Photographs by G. Kimber*

FIG. IB. A CRYPTIC HAPLOID-DIPLOID TWIN PAIR.

*To face p. 24*



seeds of a Uganda strain of Upland cotton, of which 82.3 per cent. germinated, only one cryptic twin pair and no normal ones were found. Thus both normal and cryptic twins appear to be equally rare in this variety of *G. hisutum*.

The smaller member of the Upland cryptic twin pair died at the cotyledon stage. However, both members of a set of cryptic and several sets of normal twins in Sea Island VI35 were raised to maturity, and cytological examination confirmed that the smaller member is haploid ( $2n=26$ ) and the larger diploid ( $2n=52$ ).

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Received October 1957

# THE INTERPRETATION OF SPINNING TEST REPORTS

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THE reliable evaluation of the quality of new strains of cotton by means of fibre tests and spinning tests is essential to the cotton breeder. For many years this work has been done by the Shirley Institute with whose staff the Corporation maintains close liaison, and in the Review, Vol. XXVI, No. 1, page 14, an article was published describing the methods in use at the Shirley Institute in 1948. Since that time some new fibre tests have been developed, and some slight modifications to the technique of the small-scale spinning test have followed the introduction of the "Miniature Spinning Plant." The time would seem to be opportune for the publication of a revised version of the earlier article, and in the present article the new tests will be described and some attempt will be made to indicate the significance—both statistical and practical—of the results as recorded in the reports sent to the cotton breeders.

## FIBRE TESTS

When the cottons arrive at the Shirley Institute they are checked and sampled. For the fibre tests two independent "laboratory samples" are selected; these are usually referred to as "envelope samples." Each consists of 60 to 80 "pinches," picked at random over the bulk and weighing about 30 grammes if ample material is available. Smaller samples are taken when the bulk is small, but the number of pinches per sample is kept large because of the pronounced tuft to tuft variation always encountered in raw cotton. One or more independent tests of each measured fibre characteristic are made on each laboratory sample, as a check on the testing and sampling accuracy and to give average values sufficiently precise for the purpose.

A range of fibre tests is available; some tests measure different fibre characteristics and others are alternative ways of measuring the same property. The more important groups of fibre characteristics are considered below, and notes are added on appropriate tests in use for their measurement.

### Fibre Length

One obvious feature of importance in raw cotton is *staple length*, sometimes referred to as "average staple length." This quantity should not be regarded as being the arithmetical mean or average length of all the fibres in a sample. Variations in staple length generally reflect variations either in the modal (or most frequent) length or in the length of the longer fibres in the sample. Different groups of cottons, Asiatic, American Upland, Egyptian, etc., are not usually classed on the same

basis by cotton merchants and spinners. Even within one group, different markets or users may use different levels of classification.

Numerous laboratory tests have been developed for fibre length determination, to obtain results independent of the class of cotton and, so far as possible, of the operator. One of the methods in use at the Shirley Institute is the sorter diagram technique. A sorter diagram is prepared by using a comb sorter,<sup>1</sup> a small test sample of weight about 25 mg. being arranged on a board covered with black velvet so that all the fibres are parallel and in descending order of length with their lower ends along a horizontal base line. An outline of the diagram is traced evenly through the upper ends of the fibres. By placing the tracing over graph paper, various quantities may be calculated to typify the different characteristics of the fibre length distribution. The *average length* is one quantity which may be calculated but, because equal weight is given to both long and short fibres, it often bears little relation to staple length. A quantity termed the *effective length* is determined from a simple geometrical construction.\* This construction ensures that the effective length is largely independent of the tail of short fibre in the sample and also of fluctuations in the length of the fibres close to the maximum fibre length. This length is effective in the sense that distances between pairs of drafting rollers in the spinning processes require settings for optimum performances which vary substantially with it. More generally the effective length provides a good description of a given cotton because it characterizes the length of the main bulk of the longer fibres.

*Short fibre* is estimated as the percentage number less than half the effective length.

As would be expected, the effective length is closely related to staple length, the nature of the relationship varying somewhat according to the class of the cotton.<sup>2</sup> For American Upland cottons, from about  $\frac{3}{4}$  to  $1\frac{1}{2}$  inch staple and classed on the basis of the American Staple Length Standards, a simple conversion formula is

$$\text{American staple} = 0.91 \times \text{effective length.}$$

Thus a cotton of 1 inch staple generally has an effective length equal to  $\frac{35}{36}$  inch.

For Egyptian-type cottons no staple length standards are in universal use, but on the average it is found that

$$\text{Staple length} = \text{effective length.}$$

Up to a few years ago two sorter diagrams were made on each of the two envelope samples. The effective length is quoted in units of  $\frac{1}{32}$  inch, and the four results gave an average value correct to  $\pm \frac{1}{32}$  inch. With an increased number of samples sent in for small-scale spinning tests a more rapid procedure was required. Modifications were made to an early design of a photo-electric stapler<sup>3</sup> to permit a quicker way of assessing

\* The effective length may be defined statistically as the upper quartile of the fibre length distribution curtailed below the value equal to half the effective length. Clearly the effective length is more independent of the tail of short fibre than is the upper quartile of the complete fibre length distribution.

staple length from tests on rapidly prepared fringes of parallel fibres. By use of a later version of this instrument, in conjunction with standard laboratory samples of known length, the test results may be expressed as estimates of the corresponding effective length. In this way continuity of records has been maintained. For samples sent for small-scale spinning tests, all estimates of effective length are obtained by use of the photo-electric stapler. For samples on which large-scale spinning tests are required, the number of sorter diagrams has been reduced, but additional tests are made on the photo-electric stapler and averages taken of the two sets of results. In both instances the confidence limits are about  $\pm \frac{1}{32}$  inch.

### Fibre Maturity

Cotton grown under favourable conditions consists largely of well developed "mature" fibres with fairly thick walls, but always contains some poorly developed fibres. As a result of attack by disease or pests, of unfavourable growth conditions including plant senility, or in some instances of the genetical nature of the variety, the amount of these latter so-called "immature" or "dead" fibres may form a high proportion of the whole.

In a range of fully matured cottons of diverse character the average wall thickness tends to increase with increasing maturity. For most purposes it is desirable to assess thickening independently of fibre fineness and not to measure the absolute wall thickness. The extent of wall development may be considered in terms of a ratio, the *degree of thickening* ( $\Theta$ ), equal to the ratio of the actual cross-sectional area of the wall to the area of the circle with the same perimeter. It is not generally practicable to determine the average degree of thickening directly, but it is desirable nevertheless to be able to convert any indirect assessments of fibre maturity into estimates of this geometrical quantity.

One indirect test, which has been in use at the Shirley Institute for many years,<sup>1,4</sup> depends upon classifying fibres according to their appearance under the microscope after swelling in an 18 per cent. solution of caustic soda. Well thickened fibres with many convolutions in the raw state become rod-like and show no convolutions after swelling. This type of fibre is termed *Normal* because it is the most frequent in virtually all samples of commercial cottons. *Thin-walled* and *Dead* fibres have lower degrees of thickening and after swelling are not rod-like but show a continuous lumen. In the Maturity Test a swollen fibre is classed as Dead if the ratio of the apparent width of the wall to the maximum ribbon width is one-fifth or less; thin-walled fibres have a wall thickness greater than one-fifth of the ribbon width. The test may be made on bundles of fibres taken at intervals along a sorter diagram and the percentages of Normal (N) and Dead (D) fibres determined. It has been found appropriate to combine these percentages into a single index of maturity by calculating the *maturity ratio* (M) from the relation

$$M = (N - D)/200 + 0.70$$

Values of maturity ratio equal to unity and greater are given by the

higher grades of many of the Sudan and Egyptian varieties of Egyptian type cotton. The lower grades may have values about 0·95 or less. Of the main Upland Crop in the United States, only a few samples are encountered with values of maturity ratio greater than unity: the average of the crop is about 0·9. Cotton from any country with a value for M of about 0·8, with say N=40 and D = 20, is considered to be somewhat immature. Few samples of commercial cotton have values for M of less than 0·7.

The geometrical degree of thickening is directly proportional to the maturity ratio, but for practical purposes it is generally preferable to use values of M rather than of  $\Theta$ .

#### Fibre Fineness

(a) *Gravimetric Fineness.* The average fibre weight per centimetre<sup>4</sup> length is a gravimetric measure of fibre fineness. From a comb sorter diagram five bundles of fibres may be taken at roughly equal intervals. From these bundles, centimetre lengths are cut by use of a special cutter consisting of two safety-razor blades fixed in a holder with their edges parallel and 1 cm. apart; 100 lengths are counted from each bundle and weighed on a sensitive microbalance.<sup>5</sup> The average result is expressed in units of  $10^{-8}$  grammes. Fine Sea Island cottons usually give values of about 100 for the average fibre weight per centimetre; typical values are 140 for fine and 190 for coarse Egyptian types; values from 180 to 220 are frequently encountered in the American crop and some of the Asiatic cottons often give values greater than 350.

(b) *Intrinsic Fineness.* Throughout the development of the cotton fibre the average perimeter is nearly constant; during the period of secondary wall development the average area of wall thickening (and hence the average fibre weight per centimetre) is proportional to the degree of thickening, and hence to the maturity ratio. The fibre weight per centimetre which a well-ripened sample would have obtained if the degree of thickening had coincided with the standard level, characterized by a maturity ratio equal to unity, is termed the *standard fibre weight per centimetre* ( $H_s$ ) and is given by the relation

$$H_s = H/M$$

The *standard fibre weight per centimetre* is a measure of the intrinsic fineness or coarseness of a sample because it is independent of maturity and is proportional to the square of the average fibre perimeter. The *average fibre weight per centimetre*, however, is a gravimetric measure of actual fibre fineness and is dependent upon both perimeter and maturity.

#### Micronaire Value

The Micronaire instrument<sup>6</sup> was developed in the United States and its use, particularly in the field of American cotton, is now widespread. It is valuable for assessing some aspects of the quality of commercial supplies, but care is required in the interpretation of results obtained for breeding material.

The more widespread form of test consists of taking a sample, weight 3.24 g, packing it randomly into a cylindrical holder and compressing to a fixed volume. The ends of the sample holder are perforated and compressed air may be forced through, the pressure difference across the ends being kept constant. A flowmeter is attached to the instrument to indicate variations in the flow. The scale of the instrument was experimentally calibrated in terms of average fibre weight (in microgrammes) per inch, because it was noted that cottons of low fibre weight per unit length were generally associated with low air permeabilities and cottons of high fibre weight per unit length usually gave high rates of flow.

This relation between flow and fibre weight per unit length is not exact; fibre maturity also produces a marked effect. It has been shown<sup>7</sup> that the value recorded on the flowmeter tube of the Micronaire instrument is determined by the value of  $M^2 H_s$ ,\* M being the maturity ratio and  $H_s$  the standard fibre weight per centimetre. Thus intrinsically fine cottons of low  $H_s$  tend to give low Micronaire values and intrinsically coarse cottons to give high values; an increase in maturity increases the Micronaire reading and immaturity tends to give low values.

Because the air permeability is not solely determined by the average fibre weight per unit length the readings on the instrument are regarded as "Micronaire Values," the interpretation of them being made according to the nature of the material. Other airflow instruments may be calibrated in terms of Micronaire value.

Air permeability tests on plugs of cotton fibres yield estimates of a combined function of maturity ratio (M) and standard fibre weight per centimetre ( $H_s$ ). At the Shirley Institute use is also made of a different type of test, a semi-mechanical method of estimating average fibre diameter, the details of which have not yet been published. The average fibre diameter is mainly determined by the square root of the standard fibre weight per centimetre but is also slightly affected by the fibre maturity. By tabulating functions of the fibre properties involved, in order to simplify the necessary calculations, separate estimates of M, H and  $H_s$  may be quickly and easily obtained from the results of air permeability and fibre diameter tests on a given sample. Cottons sent in for small-scale spinning tests have their maturity and fineness figures estimated by use of this technique, the labour of the other methods described in previous sections above being excessive. Samples sent in for large-scale spinning tests have values for maturity and fineness determined by both the old and new methods. This procedure leads to greater accuracy and also provides a useful check on the validity in routine practice of the development whilst the experimental details of the new technique are being perfected. The confidence limits for the average maturity and fineness figures are about  $\pm 4$  per cent.

### Single Fibre Strength

Because the number of fibres per cross-section in a yarn of a given

\* Since  $H_s = H/M$  it follows that  $M^2 H_s = MH$ , showing that both M and H produce independent effects on the instrument reading.

count varies inversely as the fibre weight per centimetre, the intrinsic tensile strength of the fibres is more important than the absolute strength. If  $F$  is the average breaking load (in grammes) and  $H$  the fibre weight per centimetre (in units of  $10^{-8}$  g/cm.) the tensile strength is  $1000F/H$ . Tensile strengths calculated in this way are expressed as a breaking length in kilometres. The breaking length in kilometres is numerically equal to a tensile strength expressed as grammes/tex. (See below.)

The determination of the strengths of single cotton fibres is very laborious and impracticable in routine testing. A considerable gain in speed is made by preparing bundles of parallel fibres, mounting them in pairs of suitable clamps, cutting them to a fixed length, determining the breaking loads and finally weighing the two broken portions of each bundle. The tensile strength of each bundle is obtained by dividing the bundle strength by the corresponding weight and then multiplying the ratio by a constant to convert the result into suitable units.

### Fibre Bundle Strength

(a) *Pressley Test.* In the standard form of this test the opposite faces of pairs of narrow clamps are in contact and thus a nominally zero specimen length may be subjected to stress. After trimming off fibres protruding from two outer faces of the clamps, leaving a bundle of fibres all having the same length, an increasing load is applied through the movement of a weight rolling down an inclined plane. The motion of the weight is arrested when the bundle breaks and the position of the weight on the inclined plane indicates the breaking load, the value being read off from a suitable scale. The combined weight of the broken portions of the bundle is determined in milligrammes. A "working measure" of tensile strength is the quantity

$$\text{Pressley Index} = \text{P.I.} = \frac{\text{breaking load in lb.}}{\text{bundle weight in mg.}}$$

In the United States an arbitrary relation has been used to relate results obtained by this test with those yielded by an older and little used Chandler Bundle Test. Because such converted Pressley Test results are frequently seen in cotton literature, the appropriate formula is given below:

$$\text{Round bundle strength (in thousands of pounds per sq. inch)} = 10.81 \times \text{P.I.} - 0.12$$

It is more satisfactory to express the tensile strength in units of grammes/tex, and international agreement on this point has recently been attained. Conversion from working units of Pressley Index is made by use of the equation

$$\text{Tensile strength (g/tex)} = 5.36 \times \text{P.I.}$$

It will be noted that doubling the tensile strength measured in g/tex gives close estimates of round bundle strength in units of thousands of pounds per square inch.

The level of test results depends markedly on the manual preparation of specimens by the operator and on the degree of wear in the

leather-covered faces of the grips. A short series of International Cotton Calibration Standard Samples is available. By making tests on these Standards at the same time as the tests are carried out on a range of cottons, or otherwise, corrections may be applied to eliminate the effects of operator and grip variations. At least sixteen bundles per sample are tested to obtain average values with confidence limits of about  $\pm 2$  per cent.

(b) *Stelometer Test.* If the jaws of the clamps holding the bundle of parallel fibres are not in close contact (*i.e.*, specimen length under test greater than zero), then the bundle strength is lower. Bundle strength decreases with increasing jaw separation. This feature is common to all textile materials; the greater the specimen length the greater is the chance of including an increased number of weak places so resulting in a reduction in the measured strength value.

Although the Pressley instrument may be modified for use with non-zero specimens, such tests are usually made on the Stelometer apparatus. Clamps of the same type are used; each pair may be held separate by a spacer of a given width. A bundle of parallel fibres is stretched under a controlled light tension across the clamps, secured in place and the protruding ends removed. The loaded clamps are subjected to an increasing load by the controlled movement of a heavy pendulum, the displacement of which is indicated by a pointer moving over a scale. When the bundle is ruptured the pointer stops, the breaking load (in kilogrammes) is read off from the calibrated scale, and the weight (in milligrammes) of the two broken portions is determined on a microbalance. The tensile strength is calculated in units of g/tex, the ratio of breaking load to specimen weight being multiplied by a constant the value of which depends on the total specimen length. An average is usually obtained from tests on sixteen bundles, with confidence limits of about  $\pm 1\frac{1}{2}$  per cent.

For most purposes a test length (clamp separation) of  $\frac{1}{8}$  inch is used.

The ratio of the tensile strength at  $\frac{1}{8}$  inch test length to that at nominally zero length is approximately 0.5. Not only are long, fine cottons usually strong, but the distribution of the strengths of elements along the length of a fibre is more uniform than for short, coarse cottons. These latter cottons therefore usually give values for the ratio of the two fibre bundle strength test results which are appreciably lower than those for long, fine cottons. Nevertheless this feature is only of a statistical nature. It is not uncommon to find a pair of samples which have identical tensile strengths when measured at, say, zero test length, but show a difference of as much as 20 per cent. with a test length of  $\frac{1}{8}$  inch.

#### Shirley Analyser Tests

Raw cotton contains varying amounts of foreign matter commonly described as "trash," the presence of which is objectionable because much of it is difficult to remove by ordinary processing methods and persists in the yarn to the detriment of the appearance and quality of the end product. The amount of trash in cotton depends largely on the method of picking and weather conditions, but it can also be affected

by characteristics of the plant such as, for example, a tendency to brittleness in the bracts. Breeder's samples are normally, of course, grown and picked with much greater care than commercial cottons, and the trash content of spinning test samples is usually small, figures around 1 and 2 per cent. being common. Since excessive trash from whatever cause is undesirable, however, it is usual for trash content measurements to be made on all samples sent for large-scale spinning tests. The measurements are made on the Shirley Analyser, a machine in which the non-cotton part of a sample is separated from the lint by a method which depends on the different buoyancies in air of cotton lint and trash. The unit size of sample for a Shirley Analyser test is 100 g and two samples are normally tested; the result is expressed as the mean of the results obtained from the two samples, and differences of less than 20 per cent. of the mean are not statistically significant. Thus, if two cottons gave mean trash contents of 1 and 1·2 per cent.,

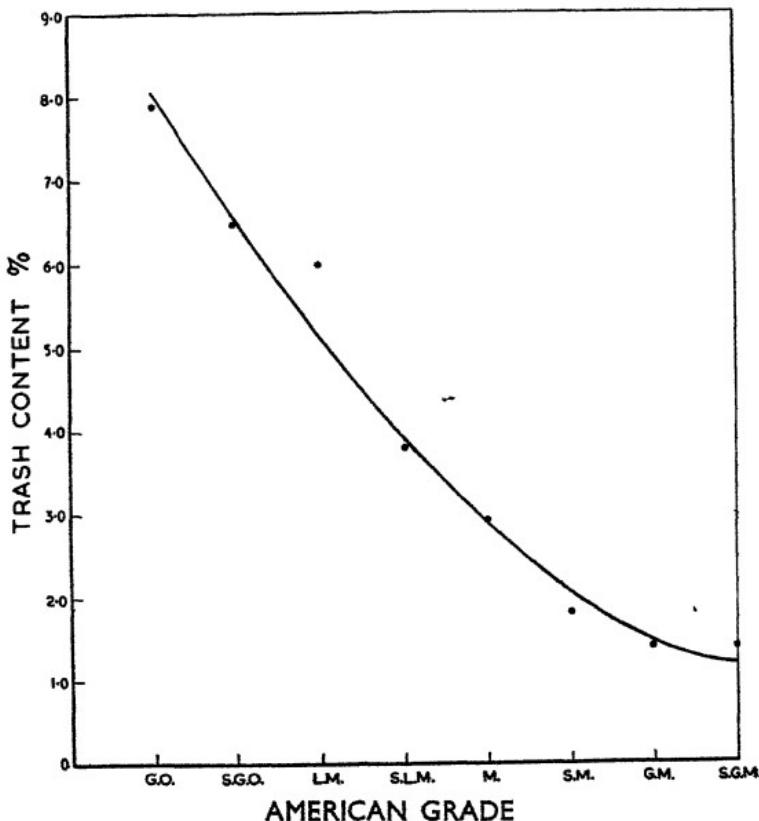


FIG. 1.—ANALYSER TRASH AND AMERICAN GRADE.

this difference would not be statistically significant; on the other hand, the chances are that values of, say, 1·5 and 2 per cent. would indicate a real difference in trash content.

Tests have been made at the Shirley Institute to investigate the relation between trash content as measured by the Shirley Analyser and the grade of the cotton. In American cottons there is a fairly close relationship, as would be expected since the grade of American cotton is largely determined by its cleanliness; the results in Fig. 1 were obtained from samples of commercial American cotton of various grades and each point is the mean of results from about eight or ten samples.

By referring to this figure the breeder can thus estimate from the percentage trash content the approximate grade (on the American basis) that would be assigned to any particular sample.

The grade of Sudan Egyptian-type cottons depends largely on intrinsic quality and is less closely connected with trash content. In general, marked differences in trash content occur only in the lower grades, and thus for this type of cotton the figure for percentage trash content does not have the same significance with respect to grade.

Because of the amount of material required for the test, "Shirley Analyser" tests can only be made on large-scale samples.

#### THE JOINT SPINNING TESTS SUB-COMMITTEE

All samples sent by the Corporation for large-scale spinning tests are examined, as soon as possible after their arrival in Manchester, by a sub-committee of spinners known as the Joint Spinning Tests Sub-Committee of the E.C.G.C. and B.C.I.R.A., who comment on the quality and general appearance of the cottons and make recommendations as to the type of yarn for which they are most suitable. The sub-committee also inspects the yarns spun from the samples, and the opinions expressed with respect to yarn appearance, neppiness, regularity, etc., are incorporated in the final report. The value of this sub-committee lies not only in the practical opinions expressed as to the quality of the samples examined, but also in the fact that it provides a useful link between the breeders and the industry; by this means new varieties can be brought to the notice of spinners much earlier than would otherwise happen, and the breeders on their side are able to gain some idea of the trade reaction to new cottons.

#### Large-scale and Small-scale Spinning Tests

It is usually the breeder who decides whether any particular sample shall be put through the large-scale or the small-scale spinning test. The choice depends first upon the amount of lint available for test; a satisfactory large-scale spinning cannot be made on less than 5 lb. of lint, and if so much is not available it would be preferable to make, say, double the usual number of small-scale tests rather than attempt a large-scale test on insufficient material. The second consideration is time. In the large-scale test the cotton passes through most of the conventional mill machines, and careful weighing is necessary at many of the stages of processing. Under ideal conditions it is not possible

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to complete a large-scale spinning test on one sample in less than about twelve hours, say two working days. A small-scale test, on the other hand, can be completed in an hour, because of the much smaller amount of material involved (42 g. or  $1\frac{1}{2}$  oz. compared with 5 lb.), the fewer processes, and the simpler technique. (See Fig. 2.)

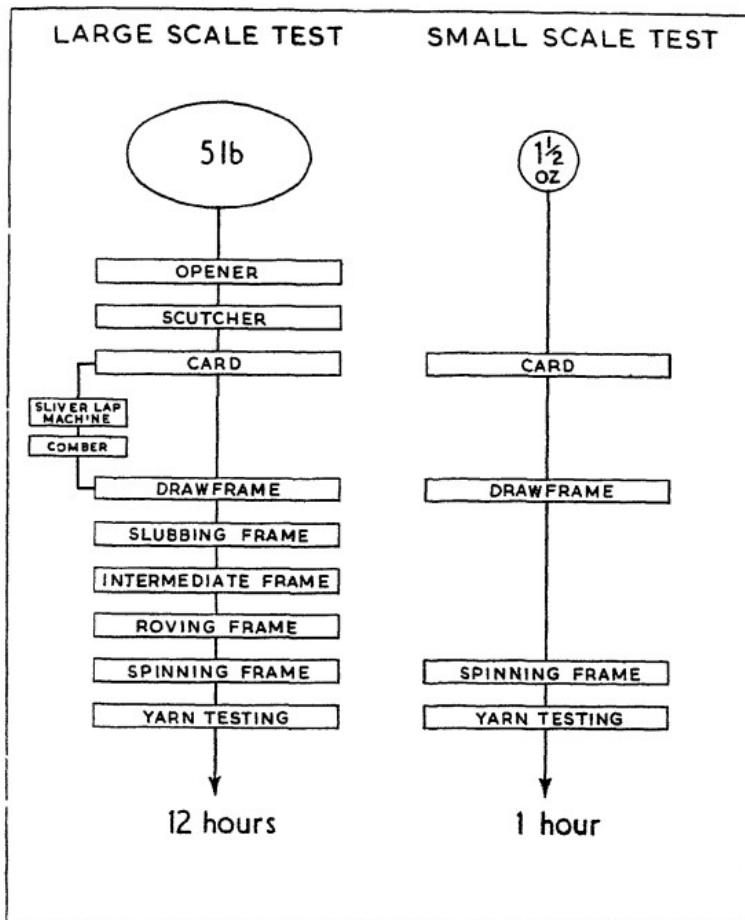


FIG. 2.

The processes of the cotton mill through which samples pass in the large-scale spinning test were described in some detail in the article referred to above; it is not proposed to repeat this description as no fundamental changes have been made in the procedure and the best verbal description gives only an inadequate picture of the processes involved; all E.C.G.C. officers are cordially invited to visit the Shirley

Institute when on leave, so that they can make themselves acquainted with the tests at first hand. Suffice it to say that the processes of *opening* and *scutching* are concerned primarily with the removal of foreign matter, the *card* with the disentangling of the fibres, further cleaning, and delivering the material in a form suitable for the next process—*drawing*. Here, the fibres are straightened and parallelized, so that the product may be further attenuated at the succeeding processes up to the actual *spinning or twisting into yarn*. In the small-scale test, whatever “*opening*” is required is done by hand as the material is being fed to the *card*, and the attenuation prior to spinning is done in one stage only at the spinning frame by means of a specially designed “*drafting*” system.

“*Combing*” is an additional process introduced after carding with the object of increasing the strength of the yarn and reducing its neppiness by removing short fibre, nep and seed-coat fragments, etc. Most of the longer stapled cottons such as Sudan Sakel, Egyptian and Sea Island are usually “*combed*” in the industry and samples of such types are therefore combed in the large-scale spinning test. It is not practicable to comb small-scale samples. The amount of waste removed in combing depends on the characteristics of the cotton and also on the machine settings, and it is the practice at the Institute to maintain a constant waste percentage (18 per cent.) for all the samples that are combed; since comber waste percentage influences yarn strength, only by this means can the strengths of combed yarns be directly compared. It should be noted than yarn spun from combed cotton is called “*combed yarn*,” whilst that spun from cotton which has not been combed is called “*carded yarn*,” although all yarn has been carded whether combed or not.

The terms “*count*” and “*twist factor*” appear on all spinning test reports, and may require a little elucidation.

The “*count*” of a yarn is a measure of its fineness and denotes the number of “*hanks*” of yarn in one pound, a “*hank*” being 840 yards. The various systems of “*numbering*” yarns which are used in different sections of the textile industry have been the subject of much discussion in recent years and many suggestions have been made for introducing a universal system. The one now recommended by the International Organization for Standardization is the “*tex*” system, in which the fineness of a yarn or fibre is expressed as the weight in grammes of one kilometre; the *tex* system is not yet in common use, however, and as it is unlikely that the old “*count*” system will be displaced for some considerable time it is retained in the spinning test reports, with the corresponding *tex* value in brackets. The corresponding *tex* is obtained simply by dividing 590·6 by the count, so that 20s count is equal to 29·5 *tex*, 80s count to 7·38 *tex*. These figures are, however, somewhat cumbersome, and it is suggested that rounded values should be used to assist in familiarizing people with the *tex* scale, until the latter is more generally accepted. The term “*tex*” also appears in connection with the fibre strength tests, the results of which are now expressed in grammes per *tex*; this is simply a means of taking into account the fineness of the fibre and is equivalent to expressing the strength in lb. per sq. inch as was formerly done in most American publications.

The adoption of the tex system will entail complete revision of yarn testing procedure. The existing specimen length for testing yarns—the lea of 120 yards—does not fit in the tex system, which is a metric system; new apparatus made to metric dimensions will be necessary, and major changes of this order can only be made very gradually. For the time, then, the conventional industrial practice for yarn testing as described below will be retained.

The count or tex of a yarn to be spun from a sample depends on its staple length and fineness. In the absence of any previous experience with similar cotton, an estimate of the staple length must be made before deciding on the suitable count, and, in the large-scale spinning tests, the advice of the Spinning Tests Sub-Committee is useful in this respect. "Hand-stapling" is usually sufficiently accurate for this purpose, and can also be used as a guide to roller settings.

The strength of a yarn is influenced by the twist inserted during spinning, commonly expressed as "turns per inch" (under the tex system turns per metre). The important factor is not, however, the number of twists per unit length, but the angle of inclination of the fibres to the yarn axis, or the degree of twist. There are more turns per inch in a fine yarn than in a coarse yarn of the same degree of twist, the relationship being

$$\text{Turns per inch} = k\sqrt{\text{count}}$$

where  $k$  is called the "twist factor."

The strength of a yarn of any given count increases with increasing twist factor up to a maximum and then begins to decrease as the twist factor is further increased. The value of the twist factor for maximum strength varies according to the characteristics of the cotton, but the curve connecting strength and twist factor has a fairly flat top and values can be chosen to give maximum strength for a wide range of cottons.

In Table I an outline is given of the processing systems used in both large-scale and small-scale spinning tests for cottons of different types. The limits of effective length, standard fibre weight, etc., are not rigid and are only intended as an indication of the characteristics of the various types of cotton.

### **Yarn Testing**

The quality of a yarn is usually assessed in terms of its tensile strength and its appearance. It is true that for some purposes other properties such as extensibility, fullness, etc., may be more important than tensile strength, but whatever its end use a yarn must be strong enough to withstand the tensions imposed in the various processes, and the most useful practical measure of cotton quality is the strength of the yarn that can be spun from it. A yarn should at the same time be free from blemishes such as nep, seed coat, etc., the effects of which are very difficult to obliterate, and which, in addition to causing trouble in processing, seriously detract from the appearance of the finished product.

In the test for yarn strength commonly used in the industry and therefore adopted for spinning test work, a lea—120 yards—of yarn is tested in the form of a loop of 80 threads on a tensile strength tester of

TABLE I  
PROCESSING OUTLINE IN SPINNING TESTS FOR DIFFERENT TYPES OF COTTON

Type	Effective length	Standard fibre weight	SSST. Count and t.f.	Large-scale ST Count and t.f., etc.
Short and coarse American	Below 32	Above 250	16s t.f. 4·0 to 5·0	12s t.f. 5·0 16s t.f. 4·0-5·0 } carded 20s t.f. 4·0 }
Raingrown Sudan, Americans, Brazilian, etc.	32-34	200-250	20s t.f. 4·0	20s t.f. 4·0 26s t.f. 4·0 } carded 32s t.f. 4·0 }
Sudan American type, N. Nigeria, Nyasaland, Uganda S47 type	34-40	170-200	40s t.f. 3·75	40s } t.f. 3·75 carded 50s }
Uganda BP52 type, Medium staple Egyptians	40-46	160-200	40s t.f. 3·75	50s } t.f. 3·75 carded 64s } 64s } t.f. 3·75 combed 80s }
Sudan Egyptian types, long staple Egyptians	44-50	140-160	80s t.f. 3·5	80s } t.f. 3·5 combed 100s } 120s }
Sea Island, MSI type	52-56	150-160	80s t.f. 3·5	120s } t.f. 3·5 double 150s }
Sea Island, St. Vincent type	60-64	100-120	80s t.f. 3·5	150s } t.f. 3·5 double 200s }

the pendulum type, the strength being expressed in lb. The broken specimen is weighed to give the "actual count" of the yarn, which may differ slightly from the nominal count. The variation of strength with count can be partially allowed for by considering the product count  $\times$  strength (CSP), but this itself varies with count, the relation being linear, of the form:  $P = a - bC$ .

The physical significance of the constants  $a$  and  $b$  will be appreciated from the diagram Fig. 3, where  $P$  is plotted vertically and  $C$  horizontally.  $a$  is the intercept on the  $P$  axis and may be taken as a measure of the ultimate strength of the cotton at "zero count." In correcting for count differences  $b$  can be used to adjust the value of  $P$  so that yarns spun to slightly different counts can be directly compared. This is the significance of the headings "Corrected lea count-strength product" in the large-scale and small-scale spinning test reports. Clearly the appropriate value of  $b$  can only be ascertained by spinning into at least two counts; this is done in the large-scale tests, but in the small-scale tests only one count is spun and the value of  $b$  must therefore be estimated from the results of large-scale spinnings of cotton of similar characteristics. Errors in the estimation of  $b$  are not serious, as the corrections to be applied are usually small, and the relative values of CSP for a number of samples will not be affected.

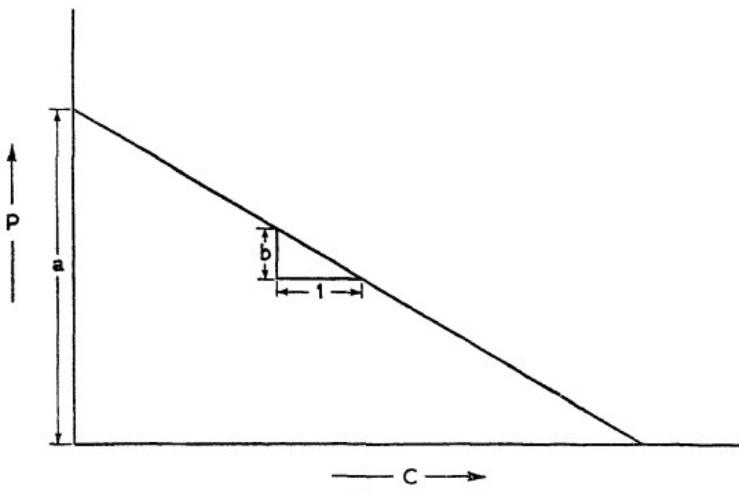


FIG. 3.

Since different cottons may give different values of  $b$  it is clear that the order of strength of two cottons may be reversed in different counts. Consider a hypothetical case of two cottons A and B, spun to 40s and 80s, the results of the tests on which are represented in Fig. 4. A gives a count-strength product of 2,500 in 40s (denoted by point P), and 1,700 in 80s (Q), with

$$b = \frac{2,500 - 1,700}{80 - 40} = 20$$

B gives a count-strength product of 2,300 in 40s (X), 1,900 in 80s (Y), with

$$b = \frac{2,300 - 1,900}{80 - 40} = 10$$

Thus in 40s A is stronger than B; in 80s B is stronger than A. An example of this occurred some years ago in two Egyptian cottons Giza 7 and Maarad. Giza 7 was a popular medium-staple cotton suitable for spinning into counts up to about 80s, whilst Maarad was a long and fine cotton recommended for counts up to 150s. It was found that in combed yarns of counts below about 100s, Giza 7, with effective length  $\frac{41}{32}$  in. and standard fibre weight 160, spun stronger yarns than Maarad, with effective length  $\frac{41}{32}$  in. and standard fibre weight 145; in counts above 100s the reverse was true. The values of  $b$  were 16 for Maarad and 21 for Giza 7.

No single figure can adequately represent the strength value of a cotton, but it is convenient to be able to express spinning quality by some simple index. For this purpose the "Highest Standard Count" is used in the large-scale spinning test reports. This is the intersection of the "Product-count" line for the particular cotton with the horizontal line representing a standard value of the product—2,000 if the yarn is carded, 2,250 if it is combed. In other words, the Highest Standard

Count is the count in which the cotton would be expected to give the standard value of count-strength product under the conditions adopted in spinning tests at the Shirley Institute. Thus, if the results represented in Fig. 4 were from carded spinnings, the Highest Standard Count for cotton A would be at  $S_1=64$ , that of cotton B at  $S_2=68$ ; if the results were from combed spinnings, the corresponding values would be  $C_1=52$  for A and  $C_2=45$  for B. Sometimes the same cotton is spun

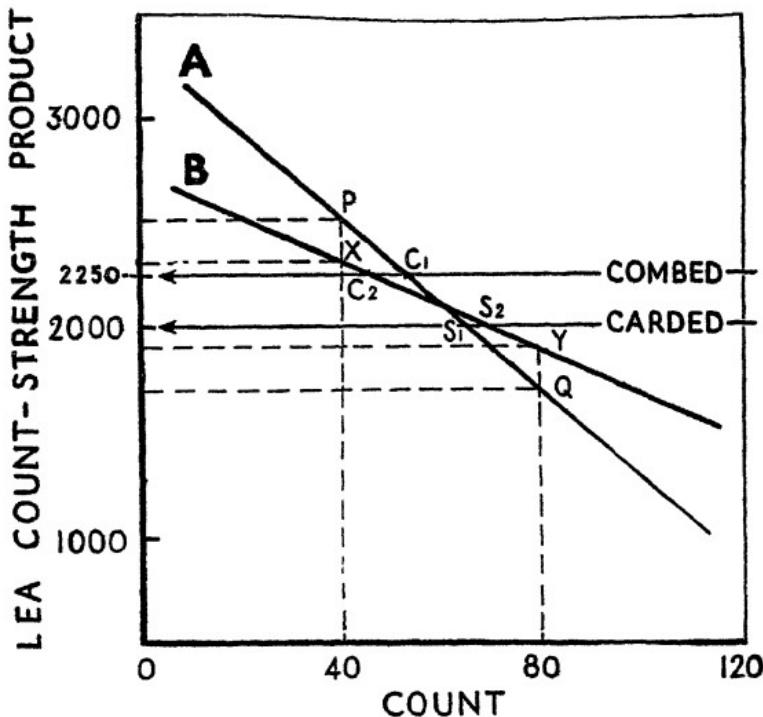


FIG. 4.

into both carded and combed yarns; then two straight lines are obtained, the intersection of the "combed" line with the 2,250 horizontal being generally at about the same value of count as that of the "carded" line with the 2,000 horizontal. Slight differences may occur, owing to the fact that cottons may show different response to combing, but the equivalence is near enough for practical purposes.

#### **Yarn Strength and Cotton Character**

Increases in fibre strength, effective length and intrinsic fineness lead to increased yarn strength; cottons containing weak, short and coarse fibres spin weak yarns. Usually long fine cottons have a high intrinsic fibre strength. Moreover, most long cottons are fine and most short

cottons are coarse. Although the relations between the various fibre characters of the world's cottons are pronounced and markedly genetic, they are subject to appreciable variation. Each of the fibre characters therefore has an independent effect on yarn strength. It is not the purpose of this paper to discuss in detail the relations between yarn strength and fibre characters but, nevertheless, a few general observations are of interest.

It has been pointed out that the lea count  $\times$  strength product (P) is linearly related to count (C), and the relation is typified by the constants  $a$  and  $b$ . For carded yarns the value of the constant  $a$  increases with increasing fibre strength, particularly with increasing strength measured with a  $\frac{1}{8}$  inch test specimen or gauge length. The value of  $b/a$ , in the equation  $P = a - bC = a(1 - Cb/a)$ , decreases as the effective length increases and the standard fibre weight per centimetre decreases. Thus a strong, long, fine cotton has higher lea count  $\times$  strength products in low counts than a weak, short coarse cotton, the differences increasing as the yarn count increases. The cause of the cross-over effect, such as that illustrated in Fig. 4, is also apparent. A very strong cotton gives a higher lea count  $\times$  strength product than a very weak cotton in low counts of yarn because it has a higher value of  $a$ . If the strong cotton is appreciably shorter and coarser than the weak cotton then it also has a higher value of  $b/a$ . The strong cotton drops more rapidly in count  $\times$  strength product with increasing count, and hence in high counts it may give a yarn appreciably weaker than that spun from the cotton with the low fibre strength.

It may be added that the relations between fibre characteristics and lea count  $\times$  strength product are not simple nor are they yet fully evaluated. For combed yarns  $a$  is possibly better related to fibre strength measured at zero gauge length than to the test results obtained using a  $\frac{1}{8}$  inch gauge length. Moreover the change in  $b/a$  for a given change in fibre length and fineness depends, as would be expected, on spinning factors such as yarn twist, whether the cottons are carded or combed, and on whether the yarn is spun from single or double roving.

#### SIGNIFICANCE OF DIFFERENCES IN COUNT STRENGTH PRODUCTS AND VALUES OF H.S.C.

Analysis of the results of large numbers of repeat tests on the large-scale system has shown that differences of less than 5 per cent. between the count-strength products of two yarns cannot be considered statistically significant. No such analysis has been made of Highest Standard Count figures, the accuracy of which depends on the values of the products relative to the standard (2000 or 2250). Generally, the highest standard count lies within the range of counts spun, in which case the accuracy of Highest Standard Count is probably slightly higher than that of either individual product. Sometimes, however, a cotton spins better or worse than was expected, and then the Highest Standard Count has to be obtained by extrapolation and the accuracy will be much less.

Analysis of spinnings on the Miniature Spinning Plant (see Appendix I)

which is now used for small-scale spinning tests has shown that the smallest significant difference between the mean products from duplicate tests is about 5 per cent., *i.e.*, of the same order as that for single tests on the large-scale system. When there is not enough material for duplicate spinnings to be made, a single test only is made and the accuracy is, of course, less in the ratio  $\sqrt{2}:1$ .

It must be emphasized that these significances are based on purely statistical grounds; in general in the industry differences rather less than these would be considered important, and when the miniature spinning test is used as a guide to the choice of cottons in a mill the necessary accuracy may be obtained by increasing the number of tests.

### **Yarn Appearance**

For some purposes the appearance of a yarn is at least as important as its strength, and must therefore be given due weight in the spinning test report. The problem lies in deciding what weight should be given to yarn appearance. Unfortunately no hard-and-fast answer can be given, but from the breeder's point of view it may be assumed that a yarn of poor appearance would almost invariably be rejected however good its strength, just as would a very weak yarn of good appearance. Yarn appearance is a complex character involving regularity, hairiness, neppiness, etc. Regularity is generally related to yarn strength; neppiness, on the other hand, is largely independent of yarn strength, and the breeder may thus be faced with a choice between two cottons one of which spins a neppy yarn of high strength and the other a weaker yarn of good appearance. Yarns are classified for appearance by reference to a series of standards which have been established over the years. The standards are numbered 1 to 7, corresponding to the descriptions, Very good, Good, Fairly good, Fair, Moderate, Poor, and Very poor. In general any grade below 4 (Fair) is unacceptable. The classes are based on general yarn appearance, but comment is usually made in the report on any notable feature, such as excessive neppiness. Ideally it would be desirable to have two separate sets of standards, one for regularity and the other for neppiness, and consideration is being given to this, though it will be some time before sufficient yarns of the different classes can be obtained.

For appearance judgment the yarns are wound on blackboards on a simple machine, the threads being spaced at regular intervals depending on the count of the yarn. The boards are stored in large filing cabinets and those from any one series of samples are generally kept until the corresponding samples from the next season's crop are spun. Thus continuity is assured, apart from reference to the standard boards. Yarns from samples sent for large-scale spinning tests are examined by the Joint Spinning Tests Sub-Committee; those from small-scale samples by members of the Shirley Institute staff, who by now have accumulated sufficient experience to be able to classify yarns with confidence.

### **Yarn Appearance and Cotton Character**

Fibre maturity is important with respect to yarn appearance, and some

aspects have been discussed in a previous article<sup>8</sup> in this Review. Freedom from nep is essential for a yarn to be of good appearance. Neps may be of two main kinds—(a) small specks on the yarn consisting of tight tangles of fibres, sometimes called "cotton" or "tangled neps"; (b) seed coat neps consisting of fragments of seed coat with lint or fuzz attached.

Cotton neps can be produced by faulty setting of the machines, especially of the card, and by excessively high rates of production. Nevertheless, even with perfectly adjusted machinery nep cannot be avoided in many cottons. Neppiness is affected by any features of the cotton which increase the liability of fibres to become entangled during mechanical operations.

A cotton of very long staple is more liable to nep than one of short staple, and the trouble is enhanced if the long staple is also accompanied by pronounced fibre fineness. It is difficult to avoid nep in cottons such as St. Vincent Sea Island, and double or treble combing is necessary to produce a sliver free from nep made during the earlier stages of processing. All fine, long Egyptian types are processed at a lower production rate than cottons of, say, the medium-staple American Upland class, and require combing if yarn appearance is to be good.

For cottons of similar length and intrinsic fibre fineness, neps are more likely to be formed from an immature cotton than from a mature one containing a high percentage of normal and a low percentage of dead fibres. The immature fibres with a thin fibre wall are much less rigid and are more ribbon-like than the more solid and rounder mature fibres. Moreover, with most dyes, neps composed of very immature fibres show up as pronounced light specks on the surface of the finished cloth. If a cotton is very immature it will generally nep in processing and give a yarn of unsatisfactory appearance; the longer and finer the cotton the greater is this tendency. A mature cotton is much more likely to yield a satisfactory yarn, but freedom from nep cannot be guaranteed even under optimum spinning conditions. The occasional occurrence of nep in a mature sample may be due to more than one reason. Possibly, because of either abnormal conditions of growth or genetic differences in fibre structure, the fibre rigidity of such a sample is less than is typical for cottons of similar fineness and maturity and the increased flexibility favours nep formation. The distribution of fibre immaturity within a sample may be important. A cotton of good average maturity but containing a small proportion of excessively immature fibres would be expected to nep more than a more uniform cotton of the same average maturity.

Seed coat nep arises from the tendency present in some cottons for the seed to break up easily in ginning.<sup>9</sup> The resulting fragments are very troublesome; not only are they extremely difficult to remove by the ordinary cleaning processes of the cotton mill, but if retained they cause serious defects in the cloth. Firstly, specks of any form are objectionable in a cloth; secondly, large seed coat neps frequently result in a distortion of the threads, and a further disadvantage is the "bleeding" of the colouring matter of the seed during alkali treatment in finishing, leading

to a spotty appearance especially in lightly prepared cloths. Even if the seed coat fragment itself is wholly dispersed in finishing, the small clumps of coarse fuzz fibres remain and generally dye a darker shade than the body of the cloth.

#### THE RELATION BETWEEN THE RESULTS OF SMALL-SCALE AND LARGE-SCALE TESTS

The reliability of spinnings on the small-scale system as a guide to the strength of yarns that can be spun on the conventional system is well established. Apart from analytical comparisons made periodically, the accumulated experience of these tests over a number of years justifies the confidence placed in them. The adoption of the new Miniature Spinning Plant (see Appendix I) followed a series of exhaustive tests in which the strengths of yarns spun on the new plant were compared with those of the yarns spun from the same cottons on the old plant; the results were the same within the limits of statistical significance discussed above. It was also found that the yarns were placed in the same order for appearance by the two tests, but the yarns spun on the new plant were invariably more neppy than those spun on the old plant. This is attributable to the difference in carding conditions. A fresh set of standards has therefore been established for the Miniature Spinning Plant, to ensure continuity in the classification for appearance. Some doubt arose as to whether the relative values for appearance would be the same on the Miniature Plant as obtained from combed yarns spun on the large-scale system; accordingly Miniature spinning tests were made on seven samples of Sudan Egyptian-type cotton which had already been spun on the large-scale system into combed yarn, and the rankings for appearance of the yarns from the two series of tests compared, with the following results:

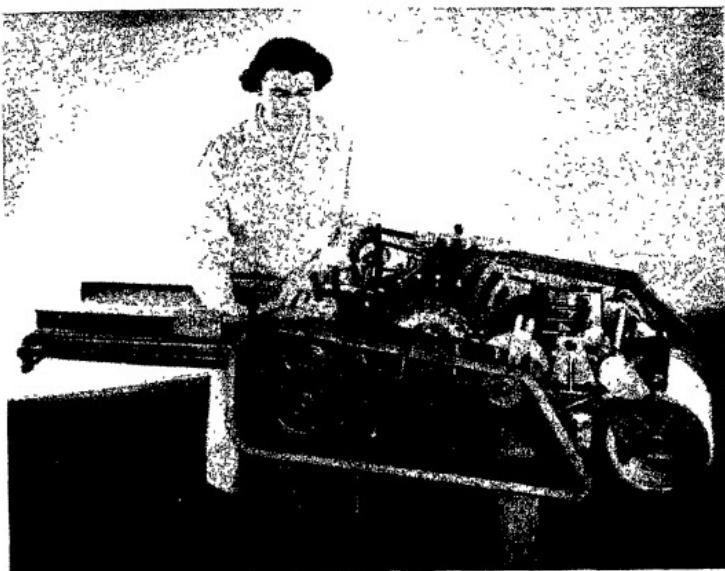
Ref. No.	Yarn appearance order	
	Large-scale combed	Small-scale (Miniature Spg. Plant)
E.528	6=	6
529	1	1
532	2	2=
534	3=	2=
537	6=	7
540	5	4=
549	3=	4=

The correspondence between the orders for the two series of tests is even better than would have been expected; although this is only an isolated example the samples are typical of Sudan Egyptian-type and it is reasonable to conclude that the small-scale test provides a satisfactory indication of the relative values of cottons not only with respect to yarn strength but also with respect to yarn appearance.

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PLATE IV



*Photograph by courtesy of the Shirley Institute.*

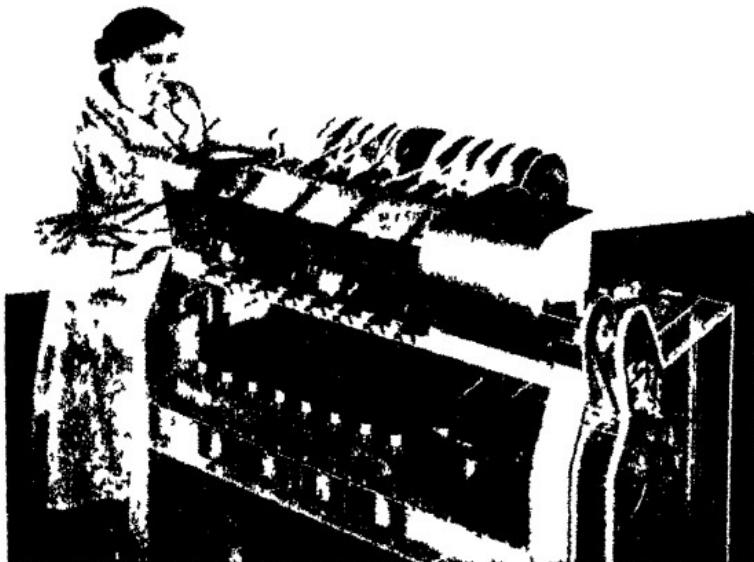
FIG. 5. MINIATURE CARD.



*Photograph by courtesy of the Shirley Institute.*

FIG. 6. MINIATURE DRAWFRAME.

PLATE V



*Photograph by courtesy of the Shirley Institute*

FIG. 7 MINIATURE SPINNING FRAME.

6. *Sheffield Corporation (U.S.A.) Textile World*, 1948, **98**, No. 1, 150.
7. E. Lord, *Shirley Inst. Mem.*, 1955, **28**, 289, or *J. Text. Inst.*, 1956, **47**, T16.
8. E. Lord, *Emp. Cott. Gr. Rev.*, 1948, **25**, 180.
9. J. Evenson, *Emp. Cott. Gr. Rev.*, 1955, **32**, 157.

## APPENDIX I

### THE MINIATURE SPINNING PLANT

When the small-scale spinning test was developed in 1940, difficulties of supply necessitated the use of existing machinery modified to suit the demands of the new test. After a time considerable interest in the small-scale spinning test was evident in the industry, and it was decided to design a set of machines specifically for the purpose of processing very small quantities of cotton. The result of this decision was the Miniature Spinning Plant which has now replaced the old small-scale spinning test machinery and is in regular use at the Institute. The Miniature Spinning Plant is now in production by Howard and Bullough Ltd., Accrington, and is being marketed through Platt Bros. (Sales) Ltd., Oldham.

The principle of the test remains, of course, unchanged. As before, only three machines—the card, drawframe and spinning frame—are necessary, but the technique of the processing has been modified to reduce waste to a minimum and to enable even smaller quantities of raw material to be spun into yarn than was possible on the old machines. In fact, on the present machines the size of sample required is largely governed by the count spun and the amount of yarn required. It is convenient, however, to standardize the size of sample and 42 grammes is the amount normally processed in spinning test work. This is sufficient to provide two leas of yarn on each of four spindles in counts from 20s upwards.

Pictures of the machines are shown in Figs. 5, 6 and 7. The card (Fig. 5) contains the same basic parts as the full-sized machine, but being so much smaller is able to deal with very much smaller quantities of material. The use of "metallic" card clothing instead of "fillet" reduces unnecessary waste to a negligible amount.

The drawframe (Fig. 6) again is fundamentally the same as the conventional machine, the main difference being the use of a drum to hold the sliver instead of a can. A very quick means of adjusting the settings of the rollers is incorporated—a feature which is invaluable when numbers of samples of different staple lengths have to be processed.

The spinning frame (Fig. 7) is a smaller and neater version of the old machine with a slightly modified drafting system which is capable of dealing with a very wide range of staple lengths.

The Miniature Spinning Plant has been in regular use for about a year and shows a marked improvement in convenience and speed.

## APPENDIX II

### SUMMARY OF SPINNING TEST TERMS

**Effective Length.** The length of the main bulk of the longer fibres. For Egyptian-type cottons the Staple Length is the same as the Effective Length, whereas in American Upland types the Effective Length is roughly 10 per cent. longer than the Staple Length.

*Short Fibre.* The percentage number of fibres of less than half the Effective Length.

*Maturity Ratio.* A measure of the average degree of fibre wall thickening. The higher grades of Sudan and Egyptian types usually have a value of about 1·0, the value of lower grades being about 0·95. The average value of the Upland crop in America is 0·9. Values of about 0·8 are considered somewhat immature and few commercial cottons have a value of less than 0·7.

*Mean Fibre Weight per Centimetre.* This depends on the degree of wall thickening of the fibres as well as on the fibre perimeter.

Fine Sea Island cottons	give a value of about	100
" Egyptian	" "	140
Coarse Egyptian types	" "	190
American Upland types	" "	190
Coarse Asiatic types	" "	300

*Standard Fibre Weight per Centimetre.* This is the fibre weight per centimetre corrected for maturity. It is a measure of intrinsic fineness, being solely determined by the fibre perimeter.

*Micronaire Value.* A method of measuring fibre fineness, by the flow of air through a plug of cotton. Fine cottons and immature cottons give low micronaire values; coarse and mature cottons give high values.

*Strength.* Fibre tensile strength is usually measured by stressing a bundle of fibres until it breaks, most conveniently expressing results in units of grammes/tex. Its value decreases as the length of fibre bundle subjected to stress increases, because of the increased chance of including weak zones in the fibres. The Pressley instrument is frequently used for making tests with nominally zero specimen length, and the Stelometer for tests on  $\frac{1}{8}$  inch specimen lengths. Tensile strengths, in grammes/tex, range from 35 to 60 for the standard Pressley test, and from 14 to 33 for the standard Stelometer test.

*Percentage Trash Content.* This is measured with the Shirley Analyser. In American cottons there is a fairly close relationship between amount of trash and grade, but with Sudan and Egyptian types grade depends more on intrinsic fibre quality, and the same relationship does not hold good.

*Count.* This is a measure of yarn fineness, and is the number of hanks (840 yards) of yarn required to weigh 1 lb. Thus, in 1 lb. of yarn of 100s count there would be 84,000 yards, whereas at a count of 50, there would be only 42,000 yards to the lb.

*Tex.* This is an alternative measure of yarn fineness which can also be applied to fibres. It is the weight in grammes of one kilometre.

#### Tarn Appearance Scale

1 .. Very good .. ..	5 .. Moderate .. ..	Doubtful
2 .. Good .. ..	6 .. Poor .. ..	
3 .. Fairly good .. ..	7 .. Very poor .. ..	Unacceptable
4 .. Fair .. ..		

Generally acceptable to spinners

## SPINNING TEST RESULTS

A brief summary is given below of the main results of tests carried out recently by the Shirley Institute on samples submitted by the Corporation.

### LARGE-SCALE TESTS

	<i>Effect- ive length</i>	<i>Stelo- meter</i>	<i>Matur- ity ratio</i>	<i>St. Fibre length</i>	<i>Count ~ strength</i>	<i>Yarn Appeari- ance</i>
<b>UGANDA</b>						
<i>Serere</i>					40s	
S47 .. .. ..	41.0	20.4	0.83	180	2356	6.0
BC177 .. .. ..	40.0	19.7	0.81	179	2304	4.0
DE715,6M .. .. ..	40.0	20.1	0.78	173	2337	4.0

DE715,6M and BC177 are both hybrids between BP52 and B181, BC177 being a promising backcross to S47. DE715,6M is to replace S47 in the Northern and Eastern Provinces, because of its better yield and quality.

					50s	
<i>Namulonge</i>						
K51 .. .. ..	42.0	20.2	0.83	171	2301	3.0
Average of 3 1955 selections ..	40.7	21.1	0.83	183	2208	3.3
7MB .. .. ..	41.0	20.6	0.87	168	2254	4.0
NC56 .. .. ..	40.0	21.9	0.86	172	2201	4.0
<i>Bukomero</i>						
Local .. .. ..	39.0	19.4	0.85	182	1981	2.0
Av. of 3 selections ..	39.7	20.4	0.82	185	2135	3.3
7MB .. .. ..	41.0	20.8	0.83	180	2141	4.0

All BP52 types, K51 being a Kawanda selection, 7MB the latest Namulonge modal bulk and NC56 the multilane strain selected in 1956 for general distribution in the BP52 area.

### SMALL-SCALE TESTS

					40s	
<i>UGANDA</i>						
C(56) Original bulk ..	41.0	20.5	0.86	189	2200	3.0
C(56) Av. of 8 selections ..	40.5	21.7	0.84	173	2324	2.2
Av. of 6 Albars .. ..	40.6	18.3	0.91	213	2036	2.2
Av. of 6 UPA's .. ..	41.8	19.5	0.79	196	2159	3.7

Routine testing for quality, C(56) is a BP52 selection. Albar is a selection from Nigerian Allen for resistance to bacterial blight, and UPA is a cross between Albar and (MU8 x BP52).

					40s	
<i>TANGANYIKA</i>						
<i>Lake Province</i>						
Uk51 Av. of 2 .. ..	40.0	19.0	0.83	203	2023	2.2
Uk55 Av. of 4 .. ..	39.5	18.8	0.83	201	1992	3.1
Selections Av. of 18 ..	40.1	18.6	0.81	205	2020	2.7
Manured land Av. of 3 ..	40.0	19.3	0.80	198	2025	3.3
Unmanured land Av. of 3 ..	39.0	18.2	0.79	214	1925	3.0
Uk55 Av. of 5 .. ..	39.4	19.2	0.86	197	1955	3.1
Albar hybrids Av. of 31 ..	39.7	19.2	0.85	203	1980	3.0
Albar hybrids Av. of 5 best ..	40.2	19.9	0.87	198	2098	2.4

To compare Albar hybrid selections with UK55 in 5 trials.

					40s	
<i>Eastern Province</i>						
IL58 Av. of 2 .. ..	40.0	19.9	0.84	151	2084	3.0
47/10 Av. of 2 .. ..	40.5	19.1	0.77	141	2041	3.5

To make sure that IL58—which may replace 47/10 later—is of the required quality standard.

					40s	
<i>SUDAN</i>						
Wilds SUS 16/1 .. ..	44.0	23.1	0.88	181	2090	7.0
Coker 100 .. ..	38.0	18.7	0.96	207	1773	6.0
Hopi Acala .. ..	36.0	25.9	1.13	163	2084	5.0
Punjab 268F .. ..	34.0	20.2	1.04	196	1515	4.0

To compare imported American types with Wilds.

## STOCKS REDISTRIBUTED AND REDUCED

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IN the cotton season ended July 31, 1957, against a reduction compared with 1955-56 of about 2 million bales in the free world's production of cotton there was an increase of nearly 1 million bales in its consumption of the fibre. There was thus the experience, unusual for recent years, of an excess of consumption over new production. The reduction in stocks was not large enough to suggest the probability that in the near future the condition of over-supply would be transformed into one of comfortable balance, much less one of even temporary shortage, but, at any rate, there was a check to the previous trend towards further additions to the surplus.

Total stocks on August 1 were indeed back to much the same level as two years previously, but over the period there were some important changes in their distribution over the various importing and exporting countries, with some decrease in the aggregate of American types and a slight increase in that of Egyptian types. The United States held some 11.3 million bales at the beginning of this season, or 3.2 million bales less than one year previously, though about 300,000 bales more than two years previously. The other net exporters, which had reduced their stocks by 1.3 million bales during 1955-56, showed a total rise of some 500,000 bales last season, though only in the Sudan and perhaps also in Egypt were the quantities at August 1, 1957, uncomfortably heavy. On the other hand, the net importers, excluding India, which had let their stocks run down by over 200,000 bales during 1955-56, increased their holdings by over 1 million bales last season. India, which had recorded a decline of 500,000 bales in 1955-56, showed a further fall of 200,000 bales in 1956-57, being one of the countries which, through shortage of foreign exchange, were unable to take advantage of the lower prices at which supplies could be bought.

TABLE I.—FREE WORLD COTTON SUPPLY  
(In million bales of 478 lb. net, except American in running bales)

	1953-54	1954-55	1955-56	1956-57	1957-58(a)
United States:					
Stocks .. ..	5.6	9.7	11.2	14.5	11.3
Production .. ..	16.4	19.6	14.7	13.0	11.0
Total .. ..	22.0	23.3	25.9	27.5	22.3
Other countries:					
Stocks .. ..	10.4	9.3	9.4	7.4	9.2
Production .. ..	14.0	16.0	16.1	15.8	16.3
Total .. ..	24.4	25.3	25.5	23.2	25.5
Total free world supply	46.4	48.6	51.4	50.7	47.8

(a) Provisional  
Source: International Cotton Advisory Committee

Re-stocking by importers last season, especially in Western Europe, was the result partly of adjustments after the hand-to-mouth buying in the previous season, and partly of indications that the improvement in textile trade would be maintained. There is consequently no assurance that these countries' buying during the current season will be on the same scale as in 1956-57, but this consideration should cause little anxiety, except in the United States and in Egypt and the Sudan, the principal producers of the longer stapled varieties.

Several considerations have emphasized in recent months the necessity of distinguishing in any appraisals of the position between the medium stapled American-type cottons and the Egyptian-type longer staples. In the first-mentioned the United States remains the dominating influence, though the proportion of the total supply for which it is responsible continues to fall. The second group is much smaller, but the influence which Egypt can exercise over it is clearly diminishing, and, moreover, because it is small, its position can be affected more radically by the emergence of even a small new source of supplies. At the same time, it is noticeable that, while the American Upland and the Egyptian Sakel and Karnak types receive a great deal of attention, few producing countries seem to be directing much thought or effort towards offering the world's spinners substantial supplies of a consistently reliable high-grade cotton of the Ashmouni type.

Another aspect of the world position is the increasing difficulty of leaving the Communist countries out of the account when considering production and distribution. Trade between the non-Communist and the Communist countries is increasing, and whereas a year or two ago Russia achieved some prominence as an exporter to the United Kingdom and elsewhere, the later trend has been for Russia and the European Communist countries to exert a significant influence on world trade through their imports of Egyptian cotton. Russia has signified its willingness to take large quantities from the Sudan, on long-term contracts if desired, and it has also placed bulk orders in Syria. Russian purchases in the Middle East are likely to be suspected of having a political purpose, but it does appear that the European Communist countries are at present short of cotton. Russia has announced an ambitious plan to increase its production to 10 million tons in the next five years, however, and if this is carried out, the Communist bloc may become a considerable exporter instead of a useful outlet for Middle Eastern surpluses. Communist China has also been a buyer in some non-Communist countries, and there have been reports that in September it purchased 17,600 bales of Uganda cotton at Kampala. In China also it is expected that further efforts will be made to increase production and to achieve independence of supplies from other sources.

### Many Increases in Acreage

The outlook for this season's new production is for a further decrease of about  $1\frac{1}{2}$  million bales after the fall of about 2 million bales in 1956-57 compared with 1955-56. There is still no tendency towards deliberate reduction outside the United States in adjustment to the lower level of

prices which United States disposals policy has brought about, and in a great many countries the area planted has been increased again in apparent disregard of the continuance of over-production in the world as a whole. Unfavourable weather and other conditions affecting the crops have played a more important part than in some recent seasons, giving a reminder that even improved fertilizers and insecticides and extended irrigation cannot entirely insulate the crops against the vagaries of nature. Total world production is tentatively put at 36·7 million bales, compared with 38 millions in 1956-57, largely because of bad weather in Russia and China, and of bad weather as well as acreage restriction in the United States, where the prospective crop is the smallest since 1950-51, and will be the main cause of a reduction of about 1½ million bales to about 27·3 million bales in the free world's production.

TABLE II.—FREE WORLD PRODUCTION OF RAW COTTON  
(In thousands of bales of 478 lb. net, except American in running bales)

	1934-38 Average	1953-54	1954-55	1955-56	1956-57	1957-58(a)
United States ..	12,389	16,402	13,630	14,685	13,029	11,010
Mexico ..	302	1,215	1,815	2,240	1,800	1,800
Salvador ..	4	60	94	132	130	140
Nicaragua ..	3	105	205	160	190	180
Brazil ..	1,793	1,465	1,635	1,700	1,350	1,450
Argentina ..	275	650	500	520	500	550
Peru ..	386	547	469	430	450	430
Egypt ..	1,846	1,467	1,805	1,541	1,498	1,964
Sudan ..	243	415	405	440	545	590
Uganda ..	273	320	265	304	315	255
French Equatorial Africa ..	34	140	150	160	165	165
Mozambique ..	27	155	140	100	140	140
Tanganyika ..	45	41	84	101	109	136
Kenya ..	13	12	12	11	11	15
Nyasaland ..	12	12	12	4	10	12
Union of S. Africa ..	2	20	34	28	30	30
Nigeria ..	47	135	170	140	145	145
Belgian Congo ..	160	235	220	245	250	250
India ..	} 5,320	{ 3,770	4,425	3,880	4,080	4,100
Pakistan ..			1,200	1,310	1,425	1,400
Burma ..	95	100	85	85	100	110
Iran ..	161	230	275	275	285	285
Iraq ..	9	17	30	35	35	70
Turkey ..	240	620	630	600	650	600
Syria ..	25	225	365	401	428	510
Greece ..	75	140	190	280	249	250
Total (b) ..	24,207	30,319	29,418	30,757	28,831	27,300

(a) Provisional      (b) Including other free countries  
Source: International Cotton Advisory Committee and Official Statistics

In the United States this season's planted area is down to 14,224,000 acres—the smallest since 1878. The figure represents only about 80 per cent. of the total of the acreage allotments, about 3 million acres having been withdrawn under the Soil Bank scheme and about 300,000 acres abandoned early in the summer because of bad weather. The

estimate of indicated production was 11,897,000 bales in August, but, with much improved weather during that month, it was raised to 12,713,000 bales in September. It was then reduced to 12,401,000 bales in October, and finally to 11,910,000 bales in December. By the end of November only 8,039,000 bales had been ginned, and the late start of the crop and the slow progress of picking and ginning makes it probable that a large proportion, particularly of the later pickings, will be low-grade, spotted cotton because of damage by rain and frost. The average yield per acre, estimated in September at 446 lb., compared with the record of 417 lb. in 1956-57, was reduced to 435 lb. in October 413 lb. in November, and 390 lb. in December.

The acreage was increased in Mexico but there was unfavourable weather in the early stages and it seems that the crop will now do well if it equals last season's. A severe drought may reduce production in Nicaragua, while in all the newer Central American producing countries it is possible that recent very high yields will not be maintained if the land is worked too enthusiastically. Salvador and Guatemala, however, have sown more cotton this year. In South America, Argentina has increased its acreage and should show a larger outturn, whereas in Brazil the emphasis has been on improved methods of cultivation which it is hoped will bring better yields per acre. Bad weather and renewed insect damage seem likely to cause a rather poor outturn in Peru. Acreage has been increased in Antigua and St. Kitts, but in St. Vincent it is thought that cotton may have lost some ground to bananas in the efforts to obtain the largest possible cash return from the land available.

Somewhat surprisingly Egypt has planted an area of 1,817,356 feddans, compared with 1,652,635 feddans in 1956-57, thereby reverting to much the same area as in 1955-56. Production is estimated at 8,543,000 kantars, against 7,061,000 kantars last season and 7,253,000 kantars the season before that. As there has been a further increase in the Sudan after the increase in the crop to last season's record of 545,000 bales (from 440,000 bales in 1955-56) a very large supply of the bulk varieties of the longer stapled types is indicated. There has been also an increase of nearly 10 per cent. in plantings in Uganda. A long period of unfavourable weather, however, has prejudiced prospects there, and whereas an increase of 11 or 12 per cent. to a new high record was originally estimated for the crop, it now seems unlikely that production will greatly exceed 250,000 bales. Earlier expectations of a very big increase in the Tanganyika crop are more likely to be realised, and present estimates place the Lake Province crop at 125,000 bales. In Nigeria also there are indications that the crop will be heavier than in the past two or three seasons. In neither Portuguese nor French Africa is there much change in prospects this season, but a larger area has been planted in the Belgian Congo.

An increase in acreage is reported in Syria, and Iraq has planted twice as much cotton as last season, but, elsewhere in the Middle East there has been no important change in Turkey or Iran, and Aden appears to be near the limit of its cultivation for the time being. Pakistan seems likely to continue its progress rapidly after last season's setback,

but India may not go much further with recovery from the setback which it had in 1955-56.

### **Big Jump in American Exports**

One of the most important aspects of the 1956-57 season as a whole was the immense increase in exports from the United States arising from the sale for export of the Commodity Credit Corporation's stocks. Between January 1956, when those sales began, and August 1957 some 12 million bales were disposed of, at prices 5 or 6 cents per lb. below the domestic support price. Exports accordingly rose to nearly 7,600,000 bales showing an increase of nearly 5,400,000 bales over the previous season's. Such an increase, when the total exports of the free countries had amounted to 11,500,000 bales in 1955-56, against 10,700,000 bales in 1954-55, might have been expected to cause a major dislocation in world trade, but it does not appear that the United States's gain brought a corresponding loss to the other exporters. Many of the other producers, for one thing, had smaller exportable surpluses for disposal as a result of larger overseas sales during the previous season when United States exports were at a low ebb. Most of them, moreover, still tend to consume increasing proportions of their own production. For another thing, a great many of the importing countries, either through lack of confidence in prices, slacker textile trade, or shortage of foreign exchange, had previously allowed their stocks to run down to uncomfortably low levels, and the United States sales programme provided them with an opportunity of replenishing their supplies.

The American/Egyptian and other extra-long-stapled varieties shared in the increase in United States exports, and, apart perhaps from Pakistan, it was mainly Egypt and the Sudan, the principal producers of long staples, which had least reason for satisfaction with their export performance in 1956-57. Egyptian exports were affected by political considerations arising from the Suez incident, and both Egypt and the Sudan were handicapped by the high prices which they asked and also by the enterprise which the world's spinners displayed in tracking down supplies of long staples from other sources and in adapting them to their own requirements or in adapting their production to the raw material available. United States irrigated types, Peruvian, Uganda and Aden cottons all benefited from this state of affairs.

Export trade both in American and Egyptian types was again subject to extraneous influences such as barter and "compensation" transactions intended to facilitate purchases where foreign exchange difficulties might have prevented them from being made. By these means opportunities of buying on very favourable terms have occasionally arisen, and the United Kingdom is at a disadvantage in that, since the cessation of central buying by a statutory body, it has no organization capable of handling bulk purchases and ensuring the equitable distribution of the supplies thus obtained.

In the first quarter of the current season exports from the United States were 1,255,000 bales, against 1,597,000 bales in the corresponding period of 1956-57, and it is expected that the decline will become much

TABLE III.—EXPORTS OF RAW COTTON  
(In thousands of bales of 478 lb. net)

	1934-38 Average	1952-53	1953-54	1954-55	1955-56	1956-57
United States	5,018	3,048	3,761	3,446	2,215	7,593
Mexico	105	988	948	1,248	2,018	1,304
Brazil*	1,065	153	1,402	1,040	815	355
Peru	337	371	395	354	491	372
Egypt	1,744	1,735	1,491	1,086	1,139	914
Sudan	257	268	415	299	561	334
In dia	293	104	210	554	N.A.	
Pakistan	2,746	1,275	898	650	726	508
Turkey	77	433	377	233	142	226
Greece	—	27	29	68	181	149

\* Via Santos only

N.A. Not available

Source: International Cotton Advisory Committee

more strongly pronounced as the season proceeds. Egypt and the Sudan have also started the season badly, but there has been a slight increase in exports from Pakistan.

### Consumption Still Rising

In 1956-57 cotton consumption in the non-Communist countries continued to increase, and in total it was probably about 5 per cent. greater than in 1955-56. There was a much wider and larger use of United States varieties, including American/Egyptian, partly because of their lower prices and the improved facilities for buying them and partly because supplies of some of the American-type "outside" growths were smaller. On the other hand, consumption of Egyptian was almost certainly, and that of Sudan probably, smaller than in the previous season, partly because of price considerations, but partly also because of technical considerations, such as increased use of man-made fibres, and a trend in cotton apparel fabrics in which medium singles yarns replace fine twofolds.

The Far East made a big contribution to the increase in total consumption. The post-war recovery in Japan took a great step forward last season, and the higher rate is being maintained, while progress continues both in India and in Pakistan, which are under the stimulus of their need to export textiles in order to provide foreign exchange for the purchase abroad of the capital goods required for their economic and industrial development schemes. Hongkong showed little further expansion in 1956-57 and so far this season is alone among the major free Asian countries in experiencing a setback.

North America has again failed to participate in the expansion. United States mills are curtailing activity because of the slackness of demand and the unremunerativeness of the prices available for textiles, and Canadian mills find their home market restricted by increased imports. The Mexican industry is handicapped by the high costs which arise from the age of its machinery and the low levels of

## THE EMPIRE COTTON GROWING REVIEW

TABLE IV.—FREE WORLD CONSUMPTION OF RAW COTTON  
(In thousands of bales of 478 lb. net)

	1934-39 Average	1952-53	1953-54	1954-55	1955-56	1956-57
United States ..	6,454	9,461	8,576	8,835	9,141	8,617
Canada ..	268	371	305	353	381	372
United Kingdom ..	2,741	1,564	1,834	1,750	1,545	1,620
France ..	1,203	1,160	1,336	1,268	1,215	1,366
W. Germany ..	1,195	1,073	1,222	1,246	1,318	1,409
Italy ..	685	864	875	804	765	885
Belgium ..	357	371	430	428	415	452
Spain ..	235	344	320	400	397	420
Netherlands ..	244	295	322	334	337	351
Sweden ..	134	120	135	136	135	148
Portugal ..	90	174	194	214	203	199
India ..	} 3,036	3,875	3,985	4,100	4,063	4,290
Pakistan ..		230	450	675	800	980
Japan ..	3,441	2,065	2,441	2,120	2,322	2,844
Hong Kong ..	—	157	204	218	223	232
Total (a) ..	22,270	25,874	26,854	27,566	28,480	29,400

N.A. Not available

(a) Including other free countries

Source: International Cotton Advisory Committee and Official Statistics

productivity which it reaches. In South America also the mills leave much to be desired in the way of up-to-dateness and efficiency, but in Argentina, Brazil, and Peru the tendency nevertheless is still for consumption to expand and to absorb larger quantities of the domestic crops.

In the last twelve months or so the leading European textile producing countries have joined the Asian ones in increasing their use of cotton. Most of them made a good recovery in 1956-57 after the set-back which all of them except Western Germany had experienced in the previous season. Belgium, France, Spain and Switzerland all show a fairly rapid expansion, with a somewhat less strongly marked increase in the Netherlands, the United Kingdom, and Western Germany, Portugal being virtually alone in showing a decline. The upturn in mill activity began to develop about the time of the Suez incident and has been surprisingly well maintained since then, in spite of the increased productions and exports achieved by the low-cost Asian producers. The course of trade in the last two or three months suggests that consumption may continue to rise in Asia, but that it will not go much further in Europe, and that there may be some further decline in North America, so that the aggregate figure for the free world for 1957-58 may be little different from that for 1956-57.

**Price Supports Maintained**

The increase in consumption has not by any means equated demand to supply, but in spite of the continued abundance of the commodity prices have still generally avoided any tendency towards a disturbing decline. For one thing, the total surplus has not prevented the

development of temporary shortages of particular types, and, though the world's spinners in the last year or two have made an impressive exhibition of their ability to maintain the quality and variety of their "mixings" while drawing the constituents from other than the traditional sources, there have been periods when one type or another has become appreciably dearer under the influence of a sudden or unusually large demand.

The United States support price for the current season is on the basis of 32·31 cents per lb. for Middling 1-inch, compared with 32·74 cents for the previous crop. This price is only of domestic application, and the world price, as represented by the prices accepted by the Commodity Credit Corporation for its sales for export from its accumulated stock of loan cotton, have been running at about 27 $\frac{1}{4}$  cents for Middling 1-inch, against about 26 $\frac{1}{4}$  cents at the corresponding

TABLE V.—SPOT PRICES, INCLUDING EXPORT TAXES, IN CERTAIN COTTON MARKETS  
(Equivalent cents per lb.)

	U.S.A.		Mexico Matamoros Midd. 1 $\frac{1}{2}$ in.	Pakistan Karachi 289F Punjab	Peru Lima Tanguis Type 5	Egypt Alexandria	
	Midd. 1 in.	Midd. 1 $\frac{1}{2}$ in.				Karnak Good	Ashraouani Good
<b>Averages:</b>							
1952-53 ..	35·32	36·00	N.A.	(a) 32·34	(a) 34·18	(a) 44·87	(a) 37·15
1953-54 ..	34·36	35·08	N.A.	32·69	37·05	46·57	37·44
1954-55 ..	35·02	36·17	34·22	33·57	36·72	51·19	41·17
1955-56 ..	N.A.	N.A.	31·59	31·65	33·87	(a) 54·76	(a) 41·23
1956-57 ..	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1955-56:							
November ..	34·84	36·05	30·97	31·09	33·34	50·44	34·44
December ..	34·81	35·92	29·27	30·65	32·64	50·67	34·96
January ..	35·17	36·31	29·81	30·03	33·06	53·31	37·13
February ..	36·20	37·41	33·16	32·70	36·16	56·56	42·36
March ..	36·45	37·67	33·08	31·32	33·48	58·18	45·84
April ..	†28·81	†30·02	32·34	32·30	33·22	66·81	51·42
May ..	†28·56	†29·77	32·17	33·99	35·68	79·45	60·15
June ..	†26·40	†27·62	32·20	32·83	34·86	75·10	52·20
July ..	†26·00	†28·11	29·96	31·17	31·27	71·37	48·43
1956-57:							
August ..	†26·10	†27·30	28·24	29·79	38·14	66·65	46·18
September ..	†26·23	†27·44	28·94	28·22	40·46	67·83	45·00
October ..	†26·34	†27·66	29·06	27·10	41·74	72·42	49·78
November ..	†26·54	†27·98	29·87	30·02	41·22	N.A.	N.A.
December ..	†26·90	†28·42	29·91	32·75	40·82	74·89	50·67
January ..	†27·09	†28·65	30·39	33·07	41·13	76·09	51·52
February ..	†27·26	†28·72	31·13	32·70	39·52	74·90	51·89
March ..	†27·41	†28·96	31·31	31·48	38·86	74·00	50·57
April ..	†27·66	†29·20	30·60	31·36	37·94	71·60	47·86
May ..	†27·75	†29·27	30·11	29·87	38·71	70·19	46·39
June ..	†27·75	†29·32	28·67	28·15	39·77	67·84	47·09
July ..	†27·86	†29·49	28·01	28·51	41·47	65·35	46·31
1957-58:							
August ..	†27·89	†29·55	27·79	29·62	40·62	62·63	46·20
September ..	†27·27	†28·93	27·61	30·25	38·08	59·09	45·49

N.A. Not available

(a) Average for less than 12 months

† Minimum C.C.C. sales price at Houston for export

Source: International Cotton Advisory Committee

time last season. In view of the poor quality of the current crop, premiums for the better grades are likely to become higher as the season proceeds.

For many "outside" growths of American type prices have been helped to remain steady or strong by the circumstance that the growing countries were able to dispose of accumulated stocks during the period when prices of United States cotton were regarded with suspicion, that subsequent crops have been smaller, or that larger requirements for domestic mills have reduced the exportable surpluses. In some countries, however, notably Turkey—which incidentally has increased its support prices for the current season by about 25 per cent. compared with 1956-57—complicated foreign exchange arrangements have obscured the prices actually received in some instances, while in others, such as Brazil, direct or indirect export subsidies have again been adopted.

Support prices have usually been fixed at, if not above, the same figures as last season's by the Governments which intervene in marketing in this way. Egypt has maintained its support prices, and, after giving warning in May, it increased its export duties from September 1. The Egyptian Government, however, is still apparently under the necessity of granting price concessions, ranging up to 20 per cent. or so of market quotations, to customers who make payment in currencies of which Egypt is particularly short.

Of the other producers of the longer staples, Peru retains a high rate of tax on exports, while Uganda has reduced its export duty by 15 per cent. but raised its support price by 4 per cent. The Sudan has continued to experience great difficulty in disposing of its record 1956-57 crop, largely because the world's spinners consider that it is not being offered at realistic prices. At the start of the selling season the export tax was raised from £E2 to £E3 per kantar, and the Sudan Gezira Board raised the reserve prices for its auction sales at Khartum. Buying proceeded haltingly; selling by private tender instead of by public auction was introduced and then abandoned; lower reserve prices were adopted in May, August, and again in November. Demand remained slack until November 19, when the Sudan Government halved its export tax, which had previously amounted to about 7½d. per lb., and the Gezira Board made yet further changes, mainly reductions, in its reserve prices. The net result was to lower prices to overseas buyers by amounts ranging from about 1d. to 5½d. per lb., and at the auctions under the new arrangements there has been a welcome expansion in sales, some of the lots fetching small premiums over the reserve prices. It is considered that prices are now on a reasonable basis, and that demand from spinners, particularly in Lancashire, will gradually be restored to a satisfactory volume as supplies previously obtained from other sources to cover current yarn sales are used up. In this way the Sudan Government, which earlier in the season had accepted in principle a Russian proposal to make bulk purchases, may be able to avoid becoming dependent on the Communist countries for outlets for its exports.

**Slower Growth in Man-made Fibres**

World production of, and trade in, man-made fibres are at present generally following trends which are clearly discernible in the British industry. The total production of man-made fibres in the United Kingdom in the first nine months of 1957 was 379 million lb., compared with 365 million lb. in the corresponding period of 1956. The rate of increase in production has become much smaller than in some recent years and, while the rate must depend to some extent on the timing of extensions of productive capacity, there has been, particularly in rayon, some slackening of output in adjustment to a state of demand in which producers have felt unable to raise their selling prices sufficiently to cover all advances in their costs of production. Rationalisation of the two large undertakings of Courtaulds Ltd. and British Celanese Ltd. since their financial merger is causing the closing-down of some rayon producing plants, the concentration of certain activities hitherto dispersed, and the removal of some duplication of both production and research operation. It is not yet clear whether the results will include net decreases in actual production or in the numbers of black-coated workers and operatives employed, but it is thought that, for the present at any rate, there will be no new projects for increasing rayon productive capacity.

It is noteworthy that the expansion in output has been more strongly pronounced in staple fibres than in filament yarns. In the United Kingdom staple fibre output was 9 million lb. higher in the nine months ended September 1957, at 200 million lb., than a year previously, while the increase in filament yarn was of only 5 million lb., to 179 million lb. These totals probably obscure some important changes in detail. In filament yarns, for example, a rather sharp fall in rayon has probably partly offset a further rise in the wholly synthetic yarns. In staple fibres rayon would probably be showing a setback but for the development of the new outlet for viscose staple in the tufted carpet industry, and it may be doubted whether an increasing use of high-tenacity staple in blends with cotton for better quality apparel fabrics is compensating for the contraction in blends of ordinary staple with cotton for the lower qualities of shirtings and dress materials. Nylon and "Terylene" staples, however, are being absorbed readily, and though Imperial Chemical Industries Ltd. has decided to cease producing its "Ardil" staple fibre, made from groundnut protein, Courtaulds Ltd. remains satisfied with the demand which it experiences for its casein staple fibre, "Fibrolane."

British Nylon Spinners Ltd. has announced that it is making extensions, at a cost of £3 or £4 millions, to its Doncaster factory, which is now the sole source of domestic production of nylon staple. This increase of capacity should be completed by the end of 1958. At much the same time Imperial Chemical Industries Ltd. announced that its productive capacity for "Terylene," now undergoing extensions to increase it from the present annual rate of 22 million lb. to 30 million lb. by the end of 1958, will be raised by a new programme just being put into execution by a further 20 million lb. "Terylene" has until

recently been regarded mainly as a competitor or co-operator with wool, but in the last few months it has attracted attention as a material for blending with cotton in apparel fabrics and as a substitute for cotton in domestic textiles, particularly as both lace and woven curtain materials. There appears to be scope for further important progress in blends of cotton with man-made fibres but, whereas rayon staple could be used as a cheapening constituent in a blend with cotton, it is usually, in blends with the wholly synthetic fibres, the cotton which is the cheapening element. The price factor will be important in determining the reaction of consumer demand to the many new blends which producers are now offering for sale, and it seems unlikely that, at current market quotations, Egyptian-type cottons will be employed to any considerable extent in the new products.

*Received November 1957*

## COTTON PRODUCTION ESTIMATES

Covering Territories in which Corporation staff are working

(Bales of 400 lb.)

Territory	Harvest completed	1957	1956
Uganda .. .	March	370,000	300,000
Kenya .. ..	March	9,200	13,000
Tanganyika:			
<i>Lake Province</i> .. .	August	150,000	—
<i>Other Provinces</i> .. .	November	17,100	—
Nyasaland .. .. ..	August	6,400	—
Nigeria .. .. ..	February	144,800	200,000
Sudan Republic:			
<i>Egyptian "S" and "L"</i> .. .	May	691,000	—
<i>American Upland</i> .. .	February	44,000	—
Aden .. .. ..	May	28,300	30,000
West Indies .. .. ..	April	3,400	5,700
Total .. .. .. ..		1,464,200	—

## WORLD PRODUCTION\*

(Bales of 478 lb.)

	Season 1956-57	% of total
United States .. .. ..	13,100,000	34.5
Mexico .. .. ..	1,800,000	4.7
Argentine .. .. ..	520,000	1.4
Brazil .. .. ..	1,350,000	3.6
Peru .. .. ..	450,000	1.2
Egypt .. .. ..	1,498,000	3.9
Other Africa .. .. ..	1,841,000	4.8
India .. .. ..	4,050,000	10.7
Pakistan .. .. ..	1,400,000	3.7
Turkey .. .. ..	650,000	1.7
Syria .. .. ..	428,000	1.1
Europe .. .. ..	513,000	1.3
Others .. .. ..	1,200,000	3.2
Free World Total .. ..	28,800,000	75.8
Communist Areas .. ..	9,200,000	24.2
World Total .. ..	38,000,000	100.0

\* From International Cotton Advisory Committee.

## ABSTRACTS

### COTTON IN AFRICA

#### Egypt

1. The first official estimate of the current crop compares with last season's final outturn as follows:

		<i>1956-57</i>	<i>1957-58</i>
		<i>Cantars</i>	<i>Cantars</i>
Karnak .. . . . .		2,132,282	2,103,000
Menoufi, Giza 45 .. . . .		829,181	1,706,000
Giza 30 & 47 and Dendera .. . . .		1,317,940	1,218,000
Ashmouni .. . . . .		2,781,510	3,123,000
		<hr/>	<hr/>
		7,060,913	8,150,000
			or about
			1,700,000 bales
			(478 lb.)
		<hr/>	<hr/>
Scarto .. . . . .		169,366	143,000

Until 1947 Egyptian production of long staple cotton (above 1½ in.) amounted to 75 per cent. of the known world crop. This proportion has dwindled through the years 1951-57 to between 50 and 60 per cent. as a result of increased production in the Sudan, Peru and other countries. Similarly the proportion of Egypt's share in the production of medium staple cotton (from 1½ in. to 1¾ in.) fell from 45-50 per cent. to 37-40 per cent.

During the past ten years there has also been a noticeable change in the direction of exports from the traditional consumers to territories within the range of influence of the Soviet Union, as may be seen from the following table:

		<i>Season</i>	<i>Season</i>	<i>Season</i>
		<i>1946-47</i>	<i>1951-52</i>	<i>1956-57</i>
England .. . . . bales		215,562	47,567	—
France .. . . . "		95,102	106,530	35,650
India .. . . . "		185,575	85,723	45,237
U.S.A. .. . . . "		114,194	66,902	22,045
Czechoslovakia .. . . . "		51,006	28,143	62,614
Russia .. . . . "		—	24,880	147,816
China .. . . . "		11,258	32,669	65,254
Yugoslavia .. . . . "		1,749	2,700	14,108
Rumania .. . . . "		—	1,486	16,050

2. **Cotton Improvement in Modern Egypt.** P. Sangwan. (*Ind. Cott. Grug. Rev.*, 11, 2, 1957, p. 93.) Part I of this paper under the sub-title "Cotton Breeding" gives a detailed account of the breeding techniques currently employed by the Ministry of Agriculture, with the objectives of raising improved varieties and maintaining the purity of established strains. Individual plant selection and hybridization are employed for raising the new varieties. The author traces each stage in the process from the selection of the initial twenty to twenty-five strains which are tested at the Giza Station each year through the phases of single progeny row, type group, purity test and pedigree lines to small-scale propagation. For the maintenance of purity, the system of seed multiplication is arranged in a pattern of concentric rings with the

nucleolus of purity tested seed at the centre. Successive generations are moved one stage further from the centre each season and thereby protect the new seed from foreign contamination.

Part II, entitled "Nucleus Seed—Its Multiplication, Distribution and Testing," is concerned with the methods whereby the seed is tested for varietal purity, germination and freedom from pests and diseases at all stages of multiplication down to large-scale commercial distribution. The success of the Government system is demonstrated by the fact that whereas by law seed produced by any individual or organization is allowed for sowing, provided it passes the purity test, in practice 99 per cent. of the commercial crop is now derived from the Ministry of Agriculture.

### Sudan

3. It is expected that the Managil Canal in northern Sudan, on which work started in May 1957, will be completed within two years. The finished canal will be 96 miles long, stretching from Sennar to Managil, and will bring a further 300,000 acres under cultivation through irrigation from the Blue Nile. The scheme will be operated by the Gezira Board, cotton and berseem being the principal crops to be produced. In accordance with their usual practice the Board will allot 20 acres of land to each settler, and will supply the heavy equipment for tillage and the planting seed. The settlers will undertake to plant, cultivate and harvest the crops, and will be paid an annual base rate plus a percentage of the profits from the sale of the crops by the Board, who will be responsible for ginning and marketing.

In October private growers formed their own organization under the name of "Sudan Cotton Growers' Association" for the purpose of handling the sales of private estates cotton. Reserve prices were fixed at Pt.20 below the equivalent Sudan Gezira Board "L" reserves and it was agreed that all cotton was to be sold by auction in the same manner and on the same days as Gezira Board cotton—sales by private treaty being debarred.

4. **Agricultural Research and Development in the South-west Sudan.** S. G. Willimott and K. R. M. Anthony. (*Tropical Agriculture*, 34, 4, 1957, p. 239.) Owing to its inaccessibility and certain other factors the southern Sudan is considered to be one of the most intractable regions of the tropics. Consequently agricultural development has proceeded there at a slower pace than in the northern provinces. To remedy this state of affairs an ecological survey was undertaken by the Administration in 1937, as a result of which the Zande Scheme was implemented in 1945 as the first major agricultural development project in the southern Sudan.

The guiding principle of the scheme was self-sufficiency, and the economic foundation was the introduction of a cotton industry involving the establishment of a modern spinning and weaving mill at Nzara. Although the experience of the first decade of the scheme's operation has produced substantial progress and results of lasting value, an examination of Azande psychology shows that a deeper understanding of tribal customs and aspirations is necessary if an acceptable scheme of development is to be evolved. The difficulties encountered in persuading the Azande to utilize effectively their most fertile soils are described, and some account is given of their reaction to the introduction of cash crops.

While the writers consider that the continuance of the Zande scheme is essential for future development in the south-west Sudan, they recommend the adoption of certain modifications and a more realistic attitude to present-day problems.

### **British West Africa**

**5. Nigeria.** 1955-56 Season. The Second Annual Report of the Nigeria Central Marketing Board (1956) gives the final cotton crop and price figures for the 1955-56 season as follows:

<i>Grade</i>	<i>Bales (400 lb.)</i>	<i>Average f.o.b. price per lb.</i>
N.A.	148,187	27·66d.
Benue	3,941	21·88d.
I.N.	1,702	23·03d.

Sales of N.A. and I.N. lint totalled £6,338,453, and seed amounting to 37,025 tons realized £859,675. The price for seed varied throughout the year from £22 1s. 0d. to £59 0s. 6d. per ton.

In the Second Annual Report of the Western Regional Marketing Board (October 1955-September 1956), it is stated that the improved prices for lint and seed during the latter half of 1955 enabled the Board to make a relatively substantial surplus on its operations during the year. In 1956, however, the market was adversely affected by the large quantity of cotton made available by the United States, and the prices for the 1956 cotton season were fixed accordingly as follows:

<i>Grade</i>	<i>Producer price (Pence per lb. seed cotton)</i>
I.N. 1	5·75
I.N. 2	5·50
I.N. 3	5·00

As there was no produce sales tax on seed cotton in the Western Region the producer price of 5d. per lb. for Grade I.N.3 cotton (which comprised 99·9 per cent. of the total) equalled that paid by the Northern Regional Marketing Board for Grade N.A.3 seed cotton after the tax had been deducted. The 1956 lint crop amounting to 1,701 bales (400 lb.) was sold at an average f.o.b. price of 23·03d. per lb. equal to an approximate producer price of 4·96d. per lb. of seed cotton after taking into account proceeds from the sale of cottonseed. The Board consequently suffered a small loss of £759 on its trading operations during the year.

The Government of Northern Nigeria reports that the British Cotton Growing Association is negotiating to build a cotton ginnery at Kumo in Gombe Emirate, costing approximately £60,000. It is hoped that the building of the ginnery will be completed in January 1958.

### **British East Africa**

**6. Uganda.** 1955-56 Season. In the Annual Report of the Department of Agriculture (1956) it is stated that cotton lint was the most valuable export commodity in the year 1956. The total realized amounted to £19,284,591, an increase of £2,898,119 (or 15 per cent.) over the figure for the previous year. The export value of other cotton products was as follows: cottonseed, £379,228; cottonseed cake, £1,537,379 and cottonseed oil, £278,043.

India normally purchases about 150,000 to 180,000 bales (400 lb.) of the Uganda crop, and the following details are taken from the Indian Central Cotton Committee's reports on A.R. Uganda cotton for 1955-56.

	<i>BP52</i>	<i>Busoga</i>	<i>Jinja</i>
Class .. .. ..	Pass	Pass	Pass
Colour .. .. ..	White	White	White
Feel .. .. ..	Silky	Silky	Silky
Staple length .. .. ..	1 $\frac{1}{8}$ in.	1 $\frac{1}{8}$ in.	1 $\frac{1}{16}$ in.
.. strength .. .. ..	Good	Good	Good
Regularity .. .. ..	Regular	Regular	Regular
Market value (pence per lb.) .. ..	39.03	37.80	33.29
Remarks .. .. ..	F.A.Q.	F.A.Q.	1 grade above F.A.Q.
Date of valuation .. .. ..	30.5.1956	30.5.1956	30.5.1956

1957-58 Season. The estimate of total plantings for the season showed an increase of 130,000 acres over the area planted in 1956, the increase being mainly in the areas growing BP52. Estimated acreages planted to the end of September with acreages planted in the corresponding period in 1956 are as follows:

	<i>To end September</i>		
	<i>1957</i>	<i>1956</i>	
Buganda Province .. .. ..	437,407	345,998	
Western .. .. ..	74,210	52,693	
Eastern .. .. ..	838,613	855,852	
Northern .. .. ..	350,478	313,996	
Protectorate total .. .. ..	1,700,708	1,568,539	

The planting season was unusually hot and dry, however, and estimates for the crop vary between 300 and 320,000 bales (400 lb.).

**7. Progress Reports from Experiment Stations, Cotton Research Station, Namulonge, Uganda, Season 1956-57.** (Emp. Cott. Gr. Corpn., 1957.) *The Farm.* A. L. Stephens and J. D. Lea. Of the 900 acres now cleared, 292 were under crops. The 78 acres under cotton yielded an average of 1,012 lb. seed cotton per acre. The estimated cost of machinery and field labour over 64 acres of bulk cotton averaged Shs. 454 per acre, of which Shs. 95 were for mechanized planting and pre-planting cultivation. The average yield of 1,076 lb. seed cotton was worth Shs. 588 per acre.

*Agricultural Meteorology and Crop Husbandry.* H. L. Manning, H. G. Farbrother and A. N. Prentice. An analysis of farm bulk yields over the last seven years showed that the highest average yields were obtained from sowings made in the second half of June. Other investigations included a field germination test and date of planting, manurial and rotation trials in relation to a double cropping system.

*Plant Physiology and Soil Science.* H. G. Farbrother, J. E. Dale and P. H. Le Mare. Red spider attack following "blanket" application of insecticides nullified the results of supplementary irrigation trials, with one exception where 3 in., 5.3 in. and 5.6 in. of supplementary irrigation gave yields of 1,180 lb., 1,640 lb. and 1,830 lb. seed cotton per acre respectively. The application of supplementary irrigation through sprinklers had no noticeable effect on the amount of blackarm damage.

Preliminary studies of the interaction of plant nutrients and supplementary water were carried out.

*Entomology.* T. H. Coaker. In the crop loss experiment a 0·2 per cent. DDT/Toxaphene mixture sprayed to run-off at weekly intervals (*a*, for the complete season, and (*b*) late in the season only, gave increased yields of 20 per cent. and 36 per cent. respectively over the unsprayed control. An outbreak of red spider mite arising from blanket application of DDT/Toxaphene was controlled by three applications of Parathion at ten-day intervals. In an attempt to assess the true nature of *Lygus* damage, the symptom of severe leaf tattering was artificially effected in *Lygus* free plants. The results showed, however, that *Lygus* damage involved some physiological disturbance to the plant in addition to the effect of the reduction of leaf surface.

*Plant Pathology.* G. M. Wickens and C. Logan. In an experiment to assess the damage caused by bacterial blight, the artificial inoculation of seed with the disease led to a significant depression of yield in comparison with the yield obtained from natural seed which had been treated with a mercurial dressing. Tests on DE715'6M, the new strain which is to replace commercial S47, showed that it had good resistance to *Verticillium* wilt.

*Plant Breeding.* H. L. Manning, R. C. Faulkner and D. E. B. Kibukamusoke. BP52/7MB gave a 21 per cent. yield increase over local BP52 in fourteen district variety trials, and two new strains, C(55)6 and C(55)3, gave a 20 per cent. increase over 7MB in trials in five localities. Progeny bulks trials of UPA and Albar showed that these strains flowered several days earlier than BP52.

*Cotton Breeding at Serere.* P. D. Walton. In small bulks trials Albar and related stocks averaging 456 lb. lint per acre easily outyielded the BP50 group, which averaged 376 lb. Albar gave two bales of lint per acre in one trial. District variety trials showed that the multiplication and distribution of DE715'6M would lead to a small yield advantage over S47, in addition to the known improvement in lint quality.

A factorial agronomy trial was carried out to test the effects of ridged and flat cultivation, three planting dates and a DDT/Toxaphene spray on S47 and Albar. The results under high fertility conditions, where flat cultivation outyielded the ridged, were reversed for low fertility conditions. The earliest planting date, namely May 29, gave the highest yield. Insecticidal spraying gave a yield increase of 29 per cent. despite the fact that *Lygus* control was not as effective as it might have been had the applications started earlier. Albar significantly outyielded S47 in terms of seed cotton, and in addition its ginning outturn was 36 per cent. as compared with 32 per cent. for S47.

**8. Uganda Seed Increase Schemes** (*Dept. of Agric. Ann. Rep.*, 1956.)  
**BP52 Strains:** As a result of breeding work carried out by the Corporation at Nambulunge, improved strains of BP52 have been made available which have been shown to produce at least 20 per cent. more lint per acre, with superior spinning quality. After a new strain is multiplied up to 70 - 80 tons of seed on experiment farms, it goes through two further stages of increase before it is issued to the whole of the Toro and Mubende Zones and thence to the rest of the BP52 area. NC54, the first new strain, is expected to produce sufficient seed to plant the Toro and Mubende Zones in 1957-58, and to complete the replacement of local BP52 in 1958 provided yields are normal. Successive annual waves of new strains will follow, each superior to its predecessor, NC54.

being followed by NC55, and in turn by NC56. Future issues will be multiplied in Bugerere County in Mengo District as well as in Busongora County.

**S47 Strains:** At the Serere Experiment Station pedigree seed is bulked up to 40 acres and sent for planting over 200-300 acres in the Mulondo area of the South Teso Segregated Zone. After two further years of multiplication within the Segregated Zone it is issued to other Teso zones and thence to other zones in the Eastern and Northern Provinces. The new strains DE715/6 and DE715/6M, having less propensity to seed coat nep than is shown by S47, are in process of multiplication in the South Teso Segregated Zone.

**9. Mechanical Cultivation in Uganda.** (*Dept. of Agric. Ann. Rep.*, 1956). During 1956 approximately 4,500 acres were ploughed by tractors under the Government contract hire service. In accordance with the policy of equating hire rates with operating costs, charges were increased to Shs. 50 per acre in Acholi and Lango Districts, for first and second ploughing of 5 acres and over, it being made clear that no contracts would be accepted for areas of less than 5 acres. This hire charge represented the full cost of the work. Parallel increases were made for other cultivations. No increases in hire charges were made in other parts of the Protectorate.

**10. Tanganyika.** It is expected that the Lake Province cotton crop for the 1957 season will exceed 150,000 bales (400 lb.).

The bulking of Uk55 on Kome Island, some 60 miles west of Mwanza in Lake Victoria, has been discontinued owing to the presence of *Fusarium* wilt on the island. A new issue of Uk55 from Ukiriguru Experiment Station near Mwanza will be bulked near Mwabagole Experiment Station inland from Bukoba.

#### Central African Federation

**11. Report of the Secretary to the Federal Ministry of Agriculture for the year ended September 30, 1956.** (Published 1957.) As a result of a succession of unusually wet seasons and continued heavy damage from red bollworm, cotton production has received a severe setback during recent years. In order to combat the pest problem, however, a scheme was brought into operation on December 1, 1956, financed equally by the Colonial Development and Welfare Fund, the Nyasaland Government and the Federal Government, whereby two entomologists were to be stationed at the Gatooma Research Station in Southern Rhodesia and a third in the main cotton growing area of Nyasaland. The cost of the scheme for the first, three years was estimated at approximately £43,000.

At the Gatooma Research Station plant breeding trials were continued with the object of transferring bacterial blight resistance from BAR4/18 to *G. hirsutum* strains, and Albar strains and crosses were examined for jassid resistance. Trials with the commercial variety 9L34 and selections made therefrom were duplicated at the Sabi Valley Station under irrigation where they gave a mean yield of 1,381 lb. seed cotton per acre as compared with 683 lb. at Gatooma. Preliminary variety trials showed the top-yielding varieties on the Sabi Station to be Nyasaland CL20 with 1,802 lb. and CL20 filter with 1,716 lb. seed cotton per acre, with Albar 51 strains taking third and fourth place. In the Gatooma trials the first four places went to Albar 51 strains, the highest being Albar 51/637 with 1,059 lb. seed cotton per acre.

Chemical control of red, American and spiny bollworms was attempted with Endrin, Endrin plus DDT, and DDT plus BHC. Owing to the extremely wet season the effects of chemical spraying were cancelled to some extent by the considerable wash-off, and in March applications were suspended on account of rainfall. Nevertheless the results showed that emulsion spray treatments (applied by pressurized hand sprayers) were superior to dusts; all emulsion treatments showed a profit over the untreated plots after deducting the value of the insecticide. Endrin gave the most profitable results, which were calculated at Shs. 138 per acre.

Experiments at the Sabi Station to determine optimum times for spraying showed that increasing the interval between applications from seven to fourteen days correspondingly increased the staining percentage from about 8 to 16 per cent. Staining in the untreated plots was about 30 per cent. The most economic treatment was six applications of 0.25 lb. Endrin per acre with fourteen-day intervals between applications. In this trial it was calculated that the profit due to insecticidal treatment was approximately £28 per acre.

**12. Southern Rhodesia.** The 1957 seed cotton crop will be purchased f.o.r. Gatooma at the following prices per lb.: Class 1, 9½d.; Class 2, 7d.; Unclassified, 4d.

**13. Nyasaland.** 1956-57 Season. Final returns for the cotton crop this year were disappointing, owing mainly to the lack of interest shown by growers after the very bad 1955-56 season. The individual returns and higher prices obtained this season, however, have stimulated interest among growers and, subject to favourable weather conditions, production should show a marked increase next year.

Seed cotton purchases were completed by mid September, and the total seasonal purchases were:

Province			1st Grade (short tons)	2nd Grade (short tons)
Southern	..	..	2,907	943
Central	..	..	137	46
Northern	..	..	243	12

There was less damage by pests and diseases to Southern Province cotton this season, but in the Central Province and Lakeshore area there was a large drop in production due largely to red bollworm. Next season the grower will receive 6d. and 2d. per lb. for Grades 1 and 2 seed cotton respectively.

1957-58 Season. Final figures for seed issued in the Karonga (Northern Province) area for the winter grown crop were 62.5 tons issued to 1,622 growers; this compares with 45 tons to 1,844 growers in 1956. The crop is reported to be growing well and the provisional estimate of yield is 350 short tons.

A new strain of cotton developed by the Corporation, which is both higher yielding and more resistant to bacterial blight, will be grown by the Agricultural Production and Marketing Board at its Toleza farm near Balaka. Some 200 acres will be planted this season and the seed from it will be distributed to African farmers in isolated areas for the following season.

**COTTON IN THE AMERICAS****United States**

**14.** The carry-over of all kinds of cotton on August 1, 1957, totalled 11,224,000 bales. The Upland carryover contained the smallest proportion of Strict Middling and higher grades in the thirty years for which records are available. The proportion of Middling was the smallest since the 1952 carryover. Strict Low Middling accounted for the largest proportion of end-season stocks since 1950 and the proportion of Low Middling and lower grades was the largest since 1952.

The November estimate of the current crop was 11,788,000 bales (500 lb. gross) with an average yield of 413 lb. per acre. Production of linters during the current season is estimated at 1,400,000 bales (600 lb. net). Cottonseed production is expected to be approximately 5,103,000 tons, assuming that the ratio of lint to seed will be the same as the average for the last five years.

The Secretary for Agriculture has announced that the acreage allotment for 1958 Upland cotton will remain unchanged from this season at 17,391,304 acres. The Upland marketing quota is 11,920,290 bales (500 lb. gross). The acreage for extra long staple is set at 83,286 acres and the marketing quota at 79,022 bales (500 lb. gross).

**15. Cotton Crop Loss Due to Pests in the United States.** See Abstract 36.

**16. Annual Varietal and Environmental Study of Fibre and Spinning Properties of Cottons, 1956 Crop.** (U.S. Dept. Agric. Res. Serv., Beltsville, June 1957.) In this report are presented the results of fibre and yarn tests on current varieties and experimental strains from the 1956 crop. The tests were made primarily to evaluate new strains and varieties that have been recently developed or are in the process of being developed throughout the cotton belt. Current commercial varieties have been included for comparison. American-Egyptian cottons are represented as well as Upland types.

**17. Rex, a New Arkansas Cotton.** B. A. Waddle (*Ark. Farm Res.*, 6, 3, 1957, p. 5.) A new strain of cotton is being released to Arkansas growers under the commercial name Rex. Developed by Carl Moosberg at the Cotton Experiment Station, Marianna, the new strain carries resistance to bacterial blight from BBR3-15-12 and the same level of *Fusarium* resistance as was carried by the Empire WR parent together with the seedling vigour and large boll characters of the latter. It has, however, higher ginning outturn and earlier maturity than either parent. Other characteristics are high yielding potential and storm resistance, a ginning outturn of 36-38 per cent., staple length of  $1\frac{1}{3}$  to  $1\frac{1}{16}$  inches and fibre quality equal or superior to that of competitive early-maturing varieties.

**18. Linters Exports, 1956-57.** (*Cotton*, M/c., 16/11/1957.) Exports from the United States totalled 334,000 bales in the 1956-57 season. This compared with the 1955-56 season's exports of 396,000 bales and the 1946-50 and 1935-39 averages of 152,000 and 264,000 bales respectively. Last season 112,000 bales were shipped to Western Germany, 63,000 to the Netherlands, 56,000 to Japan and 40,000 to the United Kingdom.

**19. Agricultural Statistics, 1956.** (U.S. Dept. Agric. For sale by the Superintendent of Documents, U.S. Govt. Printing Office, Washington 25, D.C. Pp. 608. Price \$1.75.) This publication brings together each year the statistics compiled in the Department of Agriculture and

in other Government Departments whose work concerns agriculture. The section devoted to cotton comprises twenty-four tables and includes statistics for countries outside the United States. The historical series have been generally limited to data beginning with 1940 or to the most recent ten years.

**20. The Cotton Trade Journal International Yearbook, 1956-57.** (*Cotton Trade J. Inc.*, Memphis, Tenn. Pp. 272. Price \$3.) The Yearbook contains nearly a hundred articles in which leading experts express their views on the present circumstances and future possibilities of cotton production and all aspects of the cotton industry throughout the world. Emphasis is laid on current trends in agricultural practices and the spread of industrial development in hitherto undeveloped territories.

#### West Indies

**21. 1957-58 Season. Antigua.** Germination of the new crop has been good on the whole and so far there have been no reports of pests or other trouble. If the favourable conditions continue a record crop may be expected.

*St. Kitts.* In St. Kitts the cotton crop looks promising; although some estates have found it necessary to spray the crop to control leafworm, little damage has been done.

*Nevis.* In Nevis planting began in good time and the germination was excellent, but the crop is suffering the lack of rain.

*St. Vincent.* To mid-September the Government cotton ginnery had sold 13,116 lb. of planting seed compared with 13,462 lb. at the corresponding time in 1956. It is reported that germination this year is much better than it was last year.

**22. Progress Reports from Experimental Stations, West Indies, Season 1955-56.** J. R. Spence, C. T. Cave and E. B. Lake. (Emp. Cott. Gr. Corpn., 1957.) The crops covered by this report were those planted in August-October 1955 in Antigua, Nevis and St. Vincent, and in February-April and May-June 1955 respectively in Montserrat and St. Kitts. From 1956, all Islands adopted August-October planting. The area under VH8 in Antigua increased to nearly 1,000 acres. The total acreage in Montserrat fell short of the previous season's by 15 per cent., but in Nevis an increase of over 400 acres accompanied by higher yields gave a 25 per cent. rise in production. In St. Vincent the acreage was one of the lowest for fifty years, partly owing to the failure to germinate of the first planting seed issued, but more because of the very poor returns obtained in the previous season and the competition from bananas and sweet potatoes.

Manurial trials in Antigua and Nevis failed to show the responses previously obtained from nitrogen application, presumably because soil nitrate had accumulated through the very dry close season, but there was a significant interaction in the Antigua trials between phosphate application and seed treatment with sulphuric acid to control bacterial blight disease. Better early growth followed acid treatment and allowed of greater phosphate uptake in the younger stages of the crop.

Earlier spacing trials had shown that on deep, fertile soils a plant population of 10-12,000 per acre gave the best results. Trials with the VH8 strain on poorer, shallower soils gave the best results from a population of 10,890 per acre at 4 ft.  $\times$  1 ft. spacing with one plant per

hole. Land use trials in Antigua gave increases over the control, which was continuous cotton with a weed fallow in the close season, as follows: cotton following cane, 19 per cent.; cotton after grass, 6 per cent.; continuous cotton with green manure in the close season, 21 per cent.

A *Fusarium* wilt resistance trial in St. Vincent showed wide differences between varieties, MS1 being easily the most resistant with 86 per cent. of the plants free from obvious wilt at the end of the season in comparison with 13 per cent. for V135.

Although some strains of MS1 were shown to give better yields than the commercial strain, the quality premium of VH10 and the possibility of further yield increases through selection make it a suitable replacement for MS1 in Antigua and Nevis.

Pink bollworm attack was severe, and indicated that mechanical uprooting might be less efficient than manual uprooting as a control measure. There were violent and sustained attacks of leafworm in Antigua, St. Kitts and Nevis, and in Antigua crop losses due to this pest were noticeably heavier among peasant crops than on estates. *Nezara viridula* was active in both Antigua and Montserrat. Bacterial blight was severe in Antigua on the young crop, and as before its incidence tended to be higher where *Prodenia* attack was greater. Sulphuric acid treatment as a control measure resulted in better early growth and higher final yields. The previously promising herbicide JS16 was ineffective against *Cynodon dactylon* this season owing to the drier conditions prevailing in Antigua.

### COTTON IN ASIA AND AUSTRALIA

#### Aden

**23. Progress Reports from Experiment Stations, Abyan, Aden Protectorate, Season 1956-57.** K. R. M. Anthony and J. E. A. Ogborn. (Emp. Cott. Gr. Corp., 1957.) Approximately 24,000 acres were sown to cotton in Abyan, but the yield was only 14,000 bales or 233 lb. of lint per acre as compared with the previous year's yield of a bale per acre for the 18,000 acres sown. Among the factors contributing to this reduction were late flooding and consequent late sowing, rapid closing down due to excessive and unchecked weed growth, and widespread Sudan bollworm damage. The situation was aggravated by the generally low standard of husbandry resulting largely from the absence of farming tradition in this area. In contrast, Lahej, where the standard of cultivation was satisfactory, gave a return of 10,000 bales from 8,000 acres, or 500 lb. lint per acre.

*Plant Breeding.* Variety tests confirmed that the Sudan/Egyptian "L" types were best suited to the conditions, and nucleus bulks of BAR XXI were continued. Attempts are being made to transfer the root rot resistance of Wilds Early to X1730A.

*Agronomy.* Rotation experiments have been set out. Fertilizer trials showed that a 50 per cent. yield increase could be obtained from early application of nitrogen.

*Soil Science.* In order to ascertain the amount of water required to produce a satisfactory cotton crop, a study of available data on meteorology and local practice was carried out in conjunction with a small field experiment. Preliminary results suggest that the water duty required is much less than was previously supposed, and that 33 cm. would be adequate to produce a satisfactory crop.

The report includes a note on Abyan root rot of cotton contributed by Dr. G. M. Wickens.

### India

**24. Indian Central Cotton Committee: 35th Annual Report, 1956.** (Ind. Cent. Cott. Cttee., Bombay, 1957. Price Rs.3.) The report summarizes the statistical position of cotton in India and studies to improve cotton forecasts and to determine the cost of production. In this connection, a scheme to estimate the cost of producing cotton and its rotation crops in the major cotton areas over the next three years has been approved. Progress reports are included on the genetic and physiological research investigations undertaken by the Committee, and the agronomic and extension schemes which are being carried out in the various States and Provinces of the Union. The table below shows that the percentage of the cotton crop of  $\frac{7}{8}$  in. or longer staple increased from 23 per cent. in 1950-51 to 39 per cent. in 1955-56. There has also been a steady improvement in yield except in 1955-56, when weather conditions were exceptionally unfavourable.

		1950-51	1954-55	1955-56
Area (1,000 acres)	.. ..	14,536	18,684	20,230
Production (1,000 bales)	.. ..	2,910	4,227	4,020
Yield (lb. per acre)	.. ..	89	112	90
Staple: long, $\frac{7}{8}$ in. and above	..	23%	36%	39%
medium, $\frac{3}{8}$ in.- $\frac{7}{8}$ in.	..	49%	45%	44%
short, $\frac{11}{16}$ in. and below	..	28%	19%	17%

**25. A Guide to Indian Cottons (Revised 1956).** (Ind. Cent. Cott. Cttee., Bombay, 1956. Price 8 annas.) This revision of the "Guide," which was first published in 1937, gives comprehensive information on the area, production, yield, spinning performance and special characteristics of the different varieties of Indian cottons.

**26. Indian Cotton—Its Past, Present and Future.** B. L. Sethi and K. Dharmarajulu. (Ind. Cent. Cott. Cttee., Bombay, 1957. Price Rs. 3.) After reporting briefly on the early history of cotton in India and the soil and climate of India's cotton regions, considerable attention is given to the efforts made by the Committee through the past thirty years to improve the quality and yield of various commercial Indian cottons. Their success is illustrated by the fact that in 1955-56 the area under the improved cottons evolved by the Committee's schemes was 13·6 million acres, or 67 per cent. of the total cotton area of 20·3 million acres. According to the Second Five Year Plan, the target for cotton production in 1960-61 is 6,500,000 bales (400 lb.). The present status of the textile industry and plans for its future are also briefly discussed.

### GINNING AND GINNERRIES

**27. A Study of the Effects of Converting a Single Roller Gin from Double to Single Action.** C. Nanjundayya *et al.* (Ind. Cent. Cott. Cttee. Tech. Leaflet 40, 1956.) At the Technological Laboratory it was observed that when the overlap was increased to the limit necessary for ginning long staple cottons, the output of lint per hour from double action, single roller gins was generally reduced. This leaflet records the

investigations which were undertaken to ascertain the cause of the reduction and, if possible, to remedy it.

By converting the gin from double to single action, the output of lint per hour was increased by about 20 per cent. and the power consumption was lowered by about 14 per cent. for overlaps of  $\frac{1}{16}$  in. and longer. In the seven varieties of cotton chosen for the test, no significant change was recorded in factors such as ginning percentage, mean fibre length, fibre length irregularity, blow room and card loss, and yarn characteristics such as lea strength and neppiness.

In addition to the above improvements, the following advantages have been noted in the single action ginning operation:

- (1) Reduced dropping of unginned and partly ginned seeds;
- (2) Less attention required from the operator;
- (3) Easier settings of the overlap;
- (4) Many fewer of the cut seeds which occur when ginning American varieties.

### SOILS, FERTILIZERS AND CULTIVATION

**28. Effect of Spacing on Agronomic and Fibre Characteristics of Irrigated Cotton.** R. H. Peebles *et al.* (*Tech. Bull. 1140, Arizona Agric. Exp. Sta.*, 1956. From *Field Crop Abs.*, **10**, 3, 1957, p. 194.) In 1951-52, the effects of spacing on Upland and American-Egyptian cotton were determined as regards yield, earliness, boll weight, lint percentage, seed and lint indices and fibre length, strength and fineness. Rows were spaced 36 or 38 in. apart. Spacing at 2-6 in. in the rows compared with 12-16 in. increased lint yield by 9.5 per cent. for Upland and 12.9 per cent. for American-Egyptian cotton.

Earliness in American-Egyptian cotton was greatest at 6 in. spacing but in Upland cotton, maturity was much retarded at 2 and 4 in. spacing and varied little between 6 and 16 in. Boll weight of Upland cotton declined as spacing was reduced, and, for both types, the sharpest decrease occurred when plants were spaced closer than 6 in. Lint percentage and lint index declined as spacing increased in American-Egyptian cotton. Close spacing often reduced fibre strength.

**29. Increase the Yield of Rainfed Cotton by Mulching (A Note).** A. B. Samad *et al.* (*Ind. Cott. Grug. Rev.*, **11**, 2, 1957, p. 129.) At Battambri in the drylands of the West Coast of Malabar, a very small scale preliminary observation trial was laid down in 1954-55 to ascertain whether mulching with green leaves would tide cotton sown immediately after the paddy harvest over periods of drought resulting from precarious rainfall. The variety P.216F was sown at 18 × 6 in. spacing and thinned to one plant per hole at three weeks; ammonium sulphate to supply 20 lb. nitrogen was applied before sowing and again one month after sowing. Mulching was carried out at one, two and four weeks after sowing. From an early stage, mulched plants were superior in all aspects of growth, comparative figures for mulched and non-mulched being: final height, 62.6 and 33.6 cm. respectively; squares per plant, 20 and 8.9; bolls per plant, 3 and 0.7; total yield 32 and 12 oz. seed cotton. Weeds were very sparse in mulched plots.

**30. Fertilizer Experiments in Cyprus.** P. A. Loizides (*Emp. J. Exp. Agric.*, **25**, 100, 1957, p. 278.) Three experiments were carried out with cotton under irrigation. The variety was Coker 100, an American Upland type extensively grown in Cyprus. In all three experiments

ammonium sulphate and superphosphate were applied when the seed was sown in April on varying soil types. Yields showed a significant response to both fertilizers in two of the experiments, and in one of these there was an indication that the application of both fertilizers together had an effect on lint length.

**31. Chemical Defoliation of Cotton. VII.—Effectiveness of Adjuvants under Several Specific Plant and Environmental Conditions.** L. D. Brown. (*Agronomy J.*, **49**, 10, 1957, p. 563.) The results are given of field and greenhouse tests carried out at Arizona cotton research centres with the defoliants Shed-a-leaf and X-5 in combination with Colloidal X977, Chipman Additive and other adjuvants. The tests showed that the use of adjuvants with chemical defoliants increased both the amount and rapidity of defoliation when chemicals were applied to cotton under limiting conditions such as wilted, toughened and inactive leaves, immature leaves and bolls, low temperatures, and conditions due to excessive applications of nitrogen. Under conditions favourable for defoliation such as turgid, active leaves, mature leaves and bolls, and low nitrogen, the use of adjuvants with chemical defoliants hastened leaf fall, but no significant gain in total leaf fall was evident.

**32. Progress Report on CIPC and Diuron for Pre-Emergence Weed Control in Cotton.** C. G. McWhorter and T. J. Holstun. (*Procgs. Tenth Sthn. Weed Conf.*, 1957, p. 31. From *Field Crop Abs.*, **10**, 4, 1957, p. 260.) Pre-emergence use of CIPC and Diuron, at unspecified rates, and the use of wide, flat, press-wheel planters significantly increased the yields of seed cotton. Rotary hoeing alone, or with CIPC, provided some control of weeds, but tended to be detrimental to crop stands and yields. Resowing after pre-emergence treatment with Diuron was safest if the treated areas were thoroughly disced prior to sowing. No cumulative toxicity to other crops was noted after the application of CIPC or Diuron in bands, at rates recommended for weed control in cotton.

#### MACHINERY AND MECHANIZATION

**33. A Symposium on the Operating Costs of Machinery in Tropical Agriculture.** (Colonial Advisory Council of Agriculture, Animal Health and Forestry, Pubn. No. 4, H.M.S.O., 1957.) The foreword states that though the basic principles for the use of farm machinery in temperate climates are now well understood, they cannot easily be transferred to tropical conditions. Substantial progress has been made in this direction, however, and this publication (which it is hoped will be followed by others) contains the following papers written with experience of managing agricultural machinery in the tropics. "Costs of Mechanized Agriculture in Nigeria" by W. T. Newlyn; "Analysis of Tractor Costs on a Rice Farm in Tanganyika" by N. R. Fuggles-Couchman and H. E. Hubbard; "Economic Aspects of Contract Ploughing in Uganda" by R. K. Kerkham, D. Innes and A. J. Armitage; "The Estimated Cost of Rice Production on the Proposed Small Mechanized Paddy Farms in the Federation of Malaya" by D. W. M. Haynes; "The Use of Records and Accounts in the Development of Systems of Mechanized Farming in the Tropics" and "Costing Machinery Operations" by J. R. Raeburn.

**34. The Chesterford Logarithmic Sprayer** (*World Crops*, August

1957.) The Chestersford Logarithmic Sprayer now being marketed by Fisons Pest Control Ltd. has been especially designed for the rapid evaluation of different chemicals supplied at varying rates in field trials. The principle of the machine is that it sprays an automatically decreasing dosage of a chemical as it moves along an experimental plot, thus obviating the slow and tedious task of making up a range of concentrations.

The machine can also be used to spray normally at a constant rate, or can spray a mixture of two chemicals, one at a constant rate and the other at a decreasing rate.

### PESTS AND DISEASES

**35. Cotton Crop Loss due to Pests in the United States.** In recent years insect ravages have caused cotton crop losses estimated at an annual cost of \$250 million, while in a single year, 1950, boll weevil depredations caused damage estimated at \$750 million. Approximately \$50 million is spent annually on insecticides, and a further \$20 million on applying them. Farmers have millions of dollars invested in spraying and dusting equipment, and custom application by aeroplanes has greatly increased in recent years. Nevertheless, it is estimated that insect pests still take one bale in seven.

With the reports of growing pest resistance to certain insecticides, other approaches to control are being investigated. These include improved cultural practices, and the treatment of cotton seed with systemic insecticides, while at the Brownsville Laboratory in Texas experiments have shown that a certain nematode carrying a bacterial disease will find its way through the entrance hole in a green cotton boll and destroy the pink bollworm larva. The same nematode will also penetrate a boll weevil-punctured square, find the larva or pupa, and kill it. In preliminary laboratory experiments from 80 to 90 per cent. of the pink bollworms and boll weevils were killed in this way.

**36. What's New in Control of Cotton Insects. Conventional Chemicals.** D. F. Martin. (*Procgs. Cott. Prodtn. Confce., Alabama*, December 1956. From *Field Crop Abs.*, 10, 4, 1957, p. 260.) Recent results in the control of cotton insects by phosphorus insecticides, Thiodan and calcium arsenate are discussed. For the control of thrips (*Frankliniella spp.*) three applications of Dieldrin at 0.1 lb. per acre at weekly intervals were best. For the control of boll weevil (*Anthonomus grandis*) Guthion was successful at 0.25 to 0.5 lb. per acre, and bollworm was controlled by the addition of DDT at 0.5 lb. per acre or an increased dosage of Guthion. Methyl parathion applied at 0.25 to 0.5 lb. per acre gave good control of the boll weevil, and, when 0.5 to 1.5 lb. DDT per acre was added, control of bollworm and the cabbage looper (*Trichoplusia ni*) also. EPN at 0.5 lb. per acre gave good weevil control and was equivalent to 0.34 lb. Endrin per acre. Promising control of the leaf perforator (*Bucculatrix sp.*) was obtained by using 0.375 to 0.5 lb. Phosdrin per acre.

**37. Timing Insecticide Applications for Cotton Insect Control.** C. Lincoln and T. F. Leigh. (*Agric. Exp. Sta. Fayetteville, Ark., Bull.* 588, May 1957. Pp. 46.) Since the cotton plant customarily produces more fruit than it can bring to maturity, it is considered that complete control of insect pests is unnecessary. The objective should rather be to hold pest populations at a level that will allow the plant to make a full crop

without delay in maturity or loss in quality. To do this economically, soil fertility, soil moisture, weather, cotton variety, stage of development and spacing must be considered in relation to insect infestations. Pest resistance is a further factor limiting the economic value of insecticides, and it is pointed out that if insecticide usage can be reduced, the development of resistance will be slowed down.

Experiments on the timing of insecticide applications for cotton insect control have been conducted in Arkansas for several years. This bulletin summarizes these experiments and discusses their implication in relation to the control of boll weevil, bollworms, spider mites, thrips, fleahopper, and tarnished plant bugs.

In stressing the value of predator co-operation it is pointed out that serious outbreaks of spider mite and aphid are usually a result of their predators having been killed by early application of insecticides. If application can be delayed until August, the hazard of these outbreaks is greatly reduced. The movement of predators from other plants into cotton depends on the magnitude of the predator populations and the relative attractiveness of cotton and competing hosts, presumably in terms of available prey. The persistence of predators in cotton depends on the availability of prey to encourage reproduction, continued immigration, and the delayed use of insecticides which are generally destructive to predator populations.

**38. Bayer 17147 as Cotton Insecticide.** C. F. Rainwater (*Agric. Chem.* 11, 2, 1956, pp. 32 and 107. From *Rev. App. Ent.*, 45, Ser. A, 10, 1957, p. 407.) In further tests of Bayer 17147 as a cotton insecticide it was applied in emulsion sprays and dusts at approximately 0·25 to 1 lb. per acre under weather conditions favourable for the insect. At Brownsville, Texas, where infestation was very heavy, ten weekly applications of 5 per cent. dust reduced the percentage of bolls infested by the pink bollworm (*Platelydra gossypiella*) and the number of larvae per boll from 53·2 and 1·4 to 1·3 and 0·02, respectively, and the percentage of squares punctured by the boll weevil (*Anthonomus grandis*) from 90·6 to 14·6; they also increased the yield from 668 to 2,702 lb. seed cotton per acre and improved its quality.

Fewer details are given of the results obtained in areas of Texas and Louisiana, where *A. grandis* had apparently developed resistance to chlorinated-hydrocarbon insecticides, and in Mississippi and South Carolina, but 0·25 to 0·5 lb. Bayer 17147 per acre in sprays and dusts consistently gave better control of *A. grandis* than did the chlorinated hydrocarbons usually recommended. In addition it kept aphids and mites to non-injurious levels and resulted in large increases in yield. These doses did not give satisfactory control of the bollworm (*Heliothis zea*), however, and it is suggested that DDT should be added to Bayer 17147 for simultaneous control of this and other pests.

It is considered that Bayer 17147 is no more dangerous to apply than some other phosphorus insecticides, but further investigations on the possibility of harmful residues on any part of the crop used to feed animals are necessary before it can be recommended.

(Cf. Abstract 113, Vol. 34, of this Review.)

**39. "Delnav": A New Pesticide for Cotton.** (*World Crops*, September 1957.) A new pesticide which three years of extensive tests have proved to be extremely effective in controlling a wide range of crop pests, has been announced by the Hercules Powder Company of the United States. Chemically the product is described as

dithiophosphate of dioxane. It is now commercially known as "Delnav" and is recommended by various United States authorities for use on cotton.

Depending on the type of insect and whether dusts or sprays are used, it has been found to be effective in a range of from  $\frac{1}{2}$  to  $\frac{1}{2}$  lb. of active material per acre. In the extensive testing period when the materials were used according to these recommendations no damage to the treated plants was observed. Tests to date have also shown that "Delnav" possesses a lower degree of toxicity to warm-blooded animals than is shown by most phosphate insecticides currently in use, but the normal precautions used in handling these insecticides should be taken.

**40. Boll Weevil Resistance to Poison.** A. L. Hamner and R. E. Hutchins. (*Miss. Farm Res.*, **20**, 1, 1956, 1.) As a result of the many complaints of failure to obtain satisfactory control of the boll weevil from the use of chlorinated hydrocarbon insecticides which have been received during the past two years, a series of laboratory investigations were conducted at State College during 1956 to determine if there actually is a true resistance to the commonly used insecticides such as Toxaphene, Endrin and Dieldrin.

From the results obtained it is concluded that definite resistance exists, especially in the Delta area, where there is close proximity of farms and widespread use of insecticides. It is observed, however, that the exact meaning of the findings in relation to the past cannot be determined, because no data of this kind are available on how susceptible weevils were when modern insecticides were introduced.

**41. Delta Study of Boll Weevil Resistance to Insecticides.** R. E. Furr *et al.* (*Miss. Farm Res.*, **20**, 4, 1957, p. 5.) The research reported here from the Delta Branch Station broadens the study of weevil resistance given in Abstract 40 to include field conditions. From experiments carried out with chlorinated hydrocarbons and phosphorus insecticides the following conclusions are drawn: (1) There is a difference in kill with the same insecticide when weevils are obtained from different locations. (2) Mixtures of certain phosphorus and chlorinated hydrocarbon insecticides gives better kills than either alone in field tests. (3) There is a difference in kill with the same compound as the season progresses. (4) There is a difference in kill with different chlorinated hydrocarbons and with different phosphorus insecticides. (5) Phosphorus compounds are more effective than chlorinated hydrocarbons for topical application.

**42. Methods for the Mass Rearing of the Pink Bollworm.** E. S. Vanderzant *et al.* (*J. Econ. Ent.*, **49**, 4, 1956, p. 559. From *Rev. App. Ent.*, **45**, Ser. A, 9, 1957, p. 359.) Two methods of rearing *Platynotia gossypiella* in the laboratory are described. In the first, aseptic, method, fresh peas, or peas or beans that had been allowed to sprout, were autoclaved at 15 lb. pressure for 15 and 20-25 minutes, respectively, infested with newly-hatched larvæ and kept at 84°F. The larvæ entered the seeds and did not reappear until they reached the fourth instar. When pupæ were found, these and the remaining larvæ were collected, and the larvæ were transferred to wet cotton-wool to pupate. The largest and most rapidly developing larvæ were obtained from sprouted peas; pupæ were formed in 14 days and weighed about 20 mg., so that they were comparable with field individuals. Larvæ reared on fresh peas were smaller, but all pupated in 15-18 days and gave rise to normal moths. Pupæ were formed in 16-17 days on sprouted beans

and weighed 13 mg. The same method used with sprouting cotton seeds was unsuccessful, probably because autoclaving destroyed some essential nutrient.

For the second method, delinted cotton seeds were soaked, allowed to sprout and then dipped in a solution of Butoben and methylcellulose for five minutes and allowed to dry before being infested with newly hatched larvæ or eggs about to hatch. The infested seeds were kept at a mean temperature of about 80° F. and 70-90 per cent. relative humidity. The larvæ entered the seeds, and left them to pupate after 11 or more days, which is comparable with their behaviour on cotton squares. The pupæ averaged 18.1 mg. in weight. The coating applied to the seeds prevented drying and inhibited mould growth for about a week, which was sufficient to permit larval development. Microbial decomposition within sprouting peas and beans rendered this method unsuitable for them.

**43. Studies of the Nutrition of the Pink Bollworm using Purified Casein Media.** E. S. Vanderzant and R. Reiser. (*J. Econ. Ent.*, **49**, 4, 1956, p. 454. From *Rev. App. Ent.*, **45**, Ser. A, 9, 1957, p. 346.) As the rate of growth of larvæ of *Platyedra gossypiella* and the number that pupated when reared on synthetic media containing albumen as the source of protein were low, a casein medium was substituted. Larvæ reared on this medium developed in the normal time and gave rise to adults that laid fertile eggs. Experiments to produce larger and more rapidly developing larvæ and to reduce the number entering diapause showed that a reduction in the fat content of the diet from 2 to 0.25 per cent. increased the pupation rate and decreased the number of resting larvæ, whereas the omission of cystine and glycine increased the frequency of diapause. An increase in vitamin content or the addition of yeast extract, or nucleic acid and thymine, had no effect on the growth rate or size of the larvæ. The omission of fat and choline prevented larval development, and when cholesterol was omitted, many larvæ pupated, but the pupæ were abnormal unless it was replaced by ergosterol, sitosterol or stigmasterol. Media containing 0.01 to 0.3 per cent. cholesterol produced larvæ of similar size with a similar rate of development. Larval size was increased and the growth and pupation rates accelerated when the content of sucrose in the basic medium was reduced and that of Wesson's salts increased; the optimum contents of these were found to be 4.6 and 1.2 to 1.75 per cent. respectively. (Cf. Abstract 178, Vol. 34 of this Review.)

**44. Seasonal Occurrence of Resting Larvæ of the Pink Bollworm in Central Texas.** L. C. Fife. (*J. Econ. Ent.*, **49**, 4, 1956, p. 562. From *Rev. App. Ent.*, **45**, Ser. A, 9, 1957, p. 361.) As the principal measures against *Platyedra gossypiella* on cotton are designed to reduce the population of resting larvæ, which remain dormant for several months or years before pupating, a knowledge of their seasonal abundance in different areas is desirable. Infested green bolls were collected each week of the growing season in 1955 in central Texas, and mature larvæ from them were permitted to spin cocoons under thin discs of absorbent cotton wool and kept under conditions similar to those out of doors until February 1956. They were classified as resting if they did not pupate within thirty days, and such larvæ were present in all samples, comprising 3.5 per cent. of the individuals collected in August, 25.64 per cent. in September, 93.94 per cent. in October and 100 per cent. in November. Few larvæ pupated after the 30-day period or after

December 1, when temperatures were usually too low for further development, and few exit holes were observed in late-maturing green bolls in October and November, indicating that most of the resting larvæ remain in the open bolls. It would thus be necessary to harvest an early crop and to destroy the stalks by mid-September to effect much reduction in the numbers of resting larvæ in the area, and as this is impracticable, measures should be directed towards the reduction of populations after most of the larvæ have entered the resting stage.

Resting larvæ were numerous in open bolls and locks of cotton of the 1954 crop collected from the ground or from standing stalks in January-March 1955 in fields in which maize, lucerne, small grains or cotton followed cotton, and fairly numerous in the last three in May and June; none was found from July 15 to the end of August. Open bolls from standing stalks contained 185, 91 and 50 resting larvæ per lb. on April 21, May 17 and June 10 respectively, and the first open bolls collected from two fields of the 1955 crop contained 6 and 7.5 per lb. on July 25. Moths emerged from March 17 to August 29 from infested bolls caged on November 15, 1954, and it is concluded that resting larvæ are present in every month of the year in central Texas.

**45. Some Braconid Parasites of the Pink Bollworm.** C. F. W. Muesebeck. (*Boll. Lab. Zool. Portici*, Italy, 33, 1956, p. 57. From *Rev. App. Ent.*, 45, Ser. A, 10, 1957, p. 378.) The seven parasites of *Platyedra gossypiella*, described, all from adults, are *Apanteles imitandus* and *A. parkeri* spp.n., from Brazil, *A. angaleti* and *Petalodes gossypiella* spp.n., from India, *Orgilus gossypiii* and *Chelonus liber* spp.n., from Argentina, and *Meteorus graciliventris* sp.n., from Japan. *A. haywardi* is recorded from *Platyedra gossypiella* in Brazil; it was not previously known to attack this host. The work was undertaken in connection with the introduction of certain parasites from Southern Asia into Texas for release against *P. gossypiella* on cotton there.

**46. A Method of Producing Cotton Varieties Resistant to Gummosis.** D. Verderevsky and K. Voitovich. (*Khlopovodstvo* (Cotton Raising), 7, 5, 1957, p. 37. From *Rev. App. Myc.*, 36, 10, 1957, p. 644.) In studies, begun in 1954, at the Moldavian Station of the Pan-Soviet Institute of Plant Protection, U.S.S.R., seeds of the commercial cotton varieties, 108-F, 611-B and OD-1, and two prospective varieties, 3521-U and 6466-U, selections from Ukr.NiHi, were inoculated with a suspension of *Xanthomonas malvacearum* using the vacuum infiltration method. All the infected plants (80 per cent.) were destroyed and the healthy ones reinoculated by applying the bacterial suspension with powdered glass to the lower leaf surfaces on stems of young plants. Again the remaining healthy plants were repeatedly inoculated. Of the 19,000 plants of 108-F, 97,000 of 611-B and 42,000 of OD-1 thus tested, 7, 17, and 212, respectively, were selected as immune.

In repeated inoculations the 1956 seed generation of the 1955 selection produced over 90 per cent. immune plants. Many of the first generation of selected plants did not differ morphologically from the original plants.

**47. A New Virus Disease of Cotton in Texas.** D. W. Rosberg. (*Pla. Dis. Rept.*, 41, 9, 1957, p. 726.) In 1956 a considerable number of cotton plants in the greenhouse and screenhouse of the United States Pink Bollworm Research Centre, Brownsville, Texas, developed virus-like symptoms which were characterized by a pronounced vein-clearing of affected older leaves, accompanied by the development of chlorotic areas at the tips of smaller veins. Veinbanding, intervenal yellowing, and

mottling gradually developed. Young terminal leaves first exhibited spotted intervenal yellowing and a slight to severe downward cupping. Frequently young leaves exhibited typical mosaic symptoms and puckering. All leaves developed intervenal red spotting of varying intensity, followed by degeneration of the chlorophyll and abscission. The infected plants were stunted and the terminal internodes shortened. The bolls were one-half to two-thirds normal size, with mottled bracts, and contained small and poorly filled seeds.

In many respects the symptoms of the Texas cotton virus disease resembled those of leaf curl disease of cotton reported in Sudan and Nigeria, and leaf crumple virus disease of cotton in California. However, veinbanding, conspicuous red spotting, and defoliation of older buff-coloured leaves are not reported as symptoms of the latter diseases. Moreover transmission of the virus by grafting to *Hisbicus cannabinus*, which is susceptible to the African leaf curl virus, has not been successful. Experiments to date suggest that the virus is not seed-transmitted.

**48. Temperature as a Factor in the Infection of Cotton Seedlings by Ten Pathogens.** C. H. Arndt. (*Pla. Dis. Repr., Suppl.* 246, 15/8/1957.) A number of pathogens have been shown to infect cotton seedlings and cause damping-off. The incidence of the diseases due to these pathogens varies greatly from year to year, and they are not always controlled by the fungicides used for seed treatment. This is especially true when soil conditions are favourable for seedling infection by soil-inhabiting pathogens. The discovery of more effective fungicides for their control is dependent upon detailed information of the environmental conditions under which these pathogens infect cotton seedlings.

This paper presents data on the infection of cotton seedlings by ten pathogens through a temperature range of 18° to 36°C. as follows: *Ascochyta gossypii*, 18°-27°; *Botryodiplodia phaseoli*, 18°-36°; *Colletotrichum gossypii*, 18°-33°; *Fusarium moniliforme*, 18°-36°; *F. oxysporum* f. *vasinfectum*, 18°-36°; *Pythium ultimum*, 18°-27°; *Rhizoctonia solani*, 18°-33°; *Thielaviopsis basicola*, 18°-30°; *Verticillium albo-atrum*, 18°-21°; and *Xanthomonas malvacearum*, 21°-36°. The latter produced lesions only on the cotyledons. *Botryodiplodia phaseoli* was a more aggressive parasite of the cotyledons than of the hypocotyls. Descriptions of the lesions caused by several pathogens are also included as an aid to identification of the causal pathogens under field conditions.

#### GENERAL BOTANY, BREEDING, ETC.

**49. The Progress of Recent Breeding Work on Cotton in Ceylon.** D. V. Ariyanayagam and R. T. Wijewantha. (*Tropical Agriculturist*, 112, 3, 1956, p. 251.) This paper records the work carried out at the Hambantota Cotton Research Station during the period 1952-56. The main objective of the selection work was the evolution of a cotton generally superior to the existing commercial variety, BP79. The strain S6-06, selected from 5143 Cambodia, has finally been chosen for multiplication and general cultivation throughout Ceylon under the name HC101 (Hambantota Cotton 101). Extensive tests have proved the new strain superior to all others included in the trials at every stage of testing. It has a ginning percentage of 33.8 per cent. and effective fibre length of 42/32 in. Moreover it produced the strongest yarns, spinning up to 50's satisfactorily, and had the best yarn appearance, especially in respect of neppiness.

**50. The Results of Studying the Resistance of Cotton Plants to Late Spring Frosts.** I. B. Naumović. (*J. Sci. Agric. Res., Yugoslavia*, 9, 25, 1956.) In the new regions where cotton is grown in Yugoslavia, low temperatures due to occasional late frosts in the spring are the greatest obstacles in the way of its proper development. With the object of breeding varieties which are both cold resistant and commercially satisfactory, selections were made from the plants which survived most favourably the late spring frosts which occurred from May 20-22. 1952, and which lasted for five hours at  $0^{\circ}$  to  $-6^{\circ}\text{C}$ . The best selections proved to be the strains 942 and 944. In these strains the period to boll opening has been reduced by eleven and twelve days respectively as compared with the commercial control variety 182; their yield is considerably higher and the fibre is of good quality averaging Strict Middling to Full Middling.

**51. Note on the Performance of some Inter-Specific Hybrids Involving Wild Species of *Gossypium*.** 1.—*Arboreum-anomalum Crosses*. S. M. Kalyanaraman and V. Santhanam. (*Ind. Cott. Gr. Rev.*, 11, 2, 1957, p. 136.) The potentialities of utilizing *G. anomalum* for transferring low fibre weight with high maturity to cultivated *arboreums* is briefly reported. The behaviour of  $F_1$  and first and second backcross generation hybrids as compared with parental types, and the performance of a  $BC_2F_4$  progeny of *arboreum*  $\times$  *anomalum* cross are summarized.

Low fibre weight of *G. anomalum* appears to be inherited as a dominant character in the cross *arboreum*  $\times$  *anomalum* and in the second backcross to cultivated strains. Line breeding to  $BC_2F_4$  stage has yielded progenies showing considerable improvement in yield, halo length, ginning outturn and whiteness of lint, but at the expense of fineness.

**52. Embryological Studies following Interspecific Crosses in *Gossypium*.** 1.—*G. hirsutum*  $\times$  *G. arboreum*. J. B. Weaver. (*Amer. J. Bot.*, 44, 1957, p. 209. From *Pla. Bree. Abs.*, 27, 4, 1957, p. 694.) In the cross *G. hirsutum*  $\times$  *G. arboreum*, the hybrid endosperm and maternal tissue developed only when the egg cell was not fertilized or the zygote failed to divide, large ovules without embryos being produced. With double fertilization, endosperm development ceased about six days after pollination and was followed by embryo starvation. Production by the hybrid embryo of a substance detrimental to endosperm growth is regarded as the probable cause of abortion.

Vigorous hybrids were raised with the aid of mixed pollination and embryo culture; lethal genes could not therefore have been responsible for embryo failure.

**53. Genetic Recombinations in a Hybrid involving Three Species of *Gossypium*.** C. F. Lewis. (*Agronomy J.*, 48, 8, 1957, p. 455.) An allotetraploid between two 13-chromosome species, *G. arboreum* and *G. thurberi*, was crossed with the cultivated tetraploid *G. hirsutum* to produce an allotetraploid involving three species of *Gossypium*. In the  $F_2$  progeny of this hybrid two-thirds of the plants died in the seedling stage and 43 per cent. of the surviving plants were sterile.

The  $F_2$  and  $F_3$  progenies were extremely variable in plant habit, seed cotton production, and all lint properties. Transgressive segregation was observed for some characters.

The correlation between  $F_2$  plants and the mean values of their  $F_3$  progenies was highly significant for leaf index, seed index, and lint strength, length, fineness and shape of cross section, but not significant for lint perimeter and lint index. A high positive correlation was found

in both  $F_2$  and  $F_3$  between lint fineness and lint shape which appears to be a developmental correlation.

**54. The Genetics of Flowering Response in Cotton. 1.—Fruiting Behaviour of *Gossypium hirsutum* var. *marie-galante* in a Cross with a Variety of Cultivated American Upland Cotton.** C. F. Lewis and T. R. Richmond. (*Genetics*, 42, 4, 1957, p. 499.) This paper is the first of a series in which the fruiting response of certain taxonomic varieties and geographic races of American Upland cotton will be reported. The experiment reported here was designed to study the genetics of fruiting response in a stock of *marie-galante* native to Central America. With this object the inheritance of flowering response was studied in a cross between a short-day *marie-galante* and Deltapine-14, a day-neutral strain of *G. hirsutum*. *Marie-galante* remained vegetative when grown in the field during the long days of summer, but set fruit when grown during the short days of winter in a greenhouse. Deltapine-14 set fruit in about the same length of time in both environments.

Under long-day conditions all  $F_1$  plants initiated fruit forms, but only about one-half of the plants developed a flower. This showed that neither parent was completely dominant and that the  $F_1$  was very near a threshold level for ability to flower. In each backcross the recurrent parent tended to be dominant, which suggested that the genetic background of each strain strongly influenced the expression of the genes controlling time of flowering. The segregating populations did not reveal a simple genetic ratio; neither was the segregation typical of quantitative inheritance.

Under short-day conditions all plants flowered, but even with a favourable photo-period *marie-galante* carried a lateness factor not associated with response to length of day.

It is concluded that failure to flower in the normal growing season in the Cotton Belt does not, of itself, rule out the possibility of utilizing photoperiodic cottons in genetic and breeding research.

**55. Improved Strains of Punjab American Cotton—320F.** L. S. Negi and S. L. Sehgal. (*Ind. Cott. Gr. Rev.*, 11, 2, 1957, p. 104.) The strain 320F, which was officially released for distribution in 1951 as a substitute for *desi* cotton in the Punjab, had spread over half a million acres by 1955-56, and constituted about 65 per cent. of the total cotton acreage in the region. 320F was originally selected from the Punjab American cotton L.S.S. when it was desired to raise an early maturing strain that would avoid the winter frosts. Extensive trials have shown that 320F, while maturing at least a month earlier than L.S.S., outyields the latter by more than 8 per cent. and *desi* by more than 21 per cent. The fibre is longer, finer and stronger than that of L.S.S. and the ginning outturn 1·2 per cent. higher.

#### FIBRES, YARNS, SPINNING, ETC.

**56. The Effect of Temperature on the Physical and Chemical Development of Cotton Fibre.** L. E. Hessler *et al.* (*Text. Res. J.*, 27, 4, 1957, p. 412. From *B.C.I.R.A. Summ. Curr. Lit.*, 37, 20, 1957, p. 617.) Cotton fibres formed during periods of low temperature had a decreased cellulose content and cellulose chain length, and decreased fibre wall thickness.

**57. A Device for Counting Neps in Cotton Lint and Yarn.** C.

Nanjundayya and R. L. N. Iyengar. (*Ind. Cent. Cott. Ctr.-e. Tech. Leaflet* 42, 1956.) In this paper a nep counting device is described, which could easily be constructed in any small workshop, enabling accurate and rapid determination of the nep count of raw cotton, card web, yarn, etc., to be made.

**58. The Detection of Fungal Growth in Cellulosic Textiles.** G. R. F. Rose et al. (*Text. Res. J.*, 27, 2, 1957, p. 99. From *Rx. App. Myc.*, 34, 8, 1957, p. 488.) At the National Research Laboratories, Ottawa, a modification of the Pianese IIIb staining test has proved useful in the detection of certain fungal hyphae in or on cotton, flax, viscose rayon, jute, sisal and hemp fibres. The procedure causes scarcely any swelling and therefore does not impair the structure of the fibres, nor is it appreciably affected by the presence of dyes in the material. The stain is specific for microbiological damage. It should be of great assistance in the routine examination of cellulose fibres subjected to fungal contamination in the later stages of growth or during harvesting, as in the case of cotton, or in the course of fibre separation processes involving microbiological action as in the retting of flax.

#### COTTON TRADE, PRICES, ETC.

**59. The Extra Long Staple Situation.** (*Int. Cott. Adv. Cttee.*, October 1957, and *Int. Rev. Cott. & Allied Text. Inds.*, June 1957.) Although extra long staple cottons, i.e. cottons having a staple length of more than  $1\frac{1}{2}$  in., comprise only 5 per cent. of the free world's production, they are important in the economies of the producing countries. Until recently Egypt was by far the most important exporter, with Karnak and Menoufi strains accounting for more than half the free world's total supply of approximately 1.5 million bales (478 lb. net). Within the last few years, however, there has been a considerable increase in the output of S and L cottons from the Sudan, where the 1956-57 crop rose to nearly 600,000 bales (500 lb. gross). In Peru the production of Pima and Karnak varieties has also increased with the extension of irrigation. The 1956-57 acreage was double that of 1950-51, and an average crop of around 100,000 bales may be expected.

The October estimate for 1957-58 production in the United States is 81,000 bales. Although acreage controls on extra long staple production have been operating since 1954, the reduced acreage is being rapidly counterbalanced by the spread of the high-yielding Pima S-1 variety. Because of the characteristic fineness of long staple cottons, yields in terms of lb. per acre are generally low. Pima S-1 will give 548 lb. per acre, but this is still far below the 946 lb. per acre obtained from medium staple cottons grown under similar conditions. Moreover, except for the West Indian Sea Island crop, all long staple cottons are grown under irrigation and must also be hand-harvested and roller ginned. In spite of these additional costs of production, United States farmers have found that they can grow long staple cottons profitably under price support of 75 per cent. of parity and thus compete on the home market with imported Egyptian Karnak cotton. Recently free market prices of Pima S-1 in European markets have been substantially below Karnak prices, although almost two and a half times higher than the price of U.S. Middling 1 in. Upland under the export sales programme. In dollar value, therefore, the export of a bale of Pima S-1 equals about  $2\frac{1}{2}$  bales of Upland.

The additional costs of production which supplement the natural

premium for the superior strength and fineness commanded by long staple cottons do not, however, terminate with the marketing of the lint. It takes 95 miles of a 200's count yarn to weigh a pound and exceptionally counts up to 400's can be spun, but all stages of preparation and processing are correspondingly slower in output and demand highly skilled labour for operation. So that while the resulting textiles are superior in strength and finish to those manufactured from medium stapled cottons, production costs are again considerably higher, and in consequence this range of materials has lost more heavily to competition from synthetic fibres than have either short or medium staple products.

It may be noted, therefore, that although there has been a considerable expansion in the acreage devoted to extra long staple cottons in nearly all the producing countries, ground has been lost to synthetic fibres at the consuming end of the industry; whereas in the seasons 1955-56 and 1956-57 total free world consumption of other staples has increased by nearly 2 million bales, the consumption of extra long staples has declined. Seeing that the total free world production for 1957-58 is expected to equal that of last season at 1·4 million bales, which together with stocks currently held would give a free world supply of around 2 million bales compared with 1·7 million bales in 1956-57, there are indications of a world surplus of extra long staple cottons at the end of the current market year.

**60. European Common Market for Cotton.** (*F.A.O. Monthly Bulletin of Agricultural Economics and Statistics*, 6, 7/8, 1957, p. 9.) The proposed Common Market countries, namely Belgium-Luxemburg, France, Western Germany, Italy and the Netherlands, have imported between 850,000 and 900,000 tons of cotton annually in recent years, or nearly one-third of the total moving in international trade. The Common Market as a unit would therefore represent the largest single outlet for imported cotton.

Less than 10 per cent. of the combined imports is derived from associated overseas territories in Africa. This covers their entire production. About 15 per cent. of the total is imported from Greece, Turkey, Syria and Iran. While these countries are not important producers, the cotton crop is of considerable importance to their national economies, and their output is expanding. Apart from domestic consumption, the Common Market territories take their entire crops. Imports from Mexico, Brazil, Egypt and Pakistan together account for about one-third of the total, and cover the range of types of cotton required. The United States supplies the varying residual proportion.

It is not expected that the effects on the cotton trade of the coming into force of a Common Market are likely to be drastic, largely owing to the increasingly competitive status of rayon staple which currently incurs duties ranging from 6 per cent. (Benelux) to 20 per cent. (France), whereas cotton enters duty free to all the countries concerned except Italy, where a 6 per cent. duty is levied. As the Common Market countries have close economic and political ties with their suppliers in Africa and the Middle East it is thought most likely that any cut in imports will fall on United States or Latin American cotton, trade in which is still hampered by currency difficulties.

**61. Skinner's Cotton Trade Directory of the World, 1957-58.** (Thos. Skinner and Co. (Publishers) Ltd., London. Pp. 1,387. Price £3 net.) This Directory, now in its thirty-third year of issue, remains the only comprehensive international guide to the world cotton industry.

in current publication. Each year changes are made that it is hoped will increase its usefulness, widen its scope and provide more easy reference. In this edition a major rearrangement has been introduced. Hitherto the overseas firms have been listed by countries under the section of the industry in which they are engaged. In this volume the various sections of the overseas industry are listed under headings of the countries and sub-headings of trade sections.

The main body of the Directory thus falls into two parts. The first lists British firms in the order of the processes as they are carried out in the industry, from the brokerage and handling of raw materials to the marketing of the finished product. The second is a similar compilation of overseas firms arranged according to nationality. All indexes are given in seven languages.

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#### NOTICE TO CONTRIBUTORS

Articles on all aspects of cotton growing, particularly those dealing with the results of recent research and experimentation, are invited from readers in any territory. Although there is no established limit to the length of Review articles, they should not, in general, exceed 5,000 words. Diagrams and graphs should be drawn in thick black lines on white board or paper, or tracing material, with lettering and figures written lightly in pencil in the appropriate places.

To enable copies to be sent with the minimum delay to the Editorial Advisory Panel, which is made up of members of the Corporation's Scientific Advisory Committee and Scientific Consultants, typescripts should be submitted in duplicate and addressed to:

The Assistant Editor,  
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Eccleston Street,  
London, S.W.1.

Contributors will receive twenty offprints free of charge, and may purchase further offprints at the cost of printing, provided that the order is received when the proof is returned.

## CURRENT NOTES

WITH deep regret we record the death of Lieutenant-Colonel Wentworth Schofield, T.D., M.P., who had been a member of the Corporation's Administrative Council since 1954.

Mr. J. C. May, C.M.G., O.B.E., Director of the Corporation, again presided at the annual meeting of the Advisory Board of the Namulonge Research Station, Uganda, which was held on December 11. The meeting was attended by representatives of a number of the cotton growing territories which are partners in the work of the Station. Before his return to England early in January, Mr. May will visit Aden and the Sudan Republic.

Sir Joseph Hutchinson, C.M.G., F.R.S., has accepted appointment as a member of the Scientific Advisory Committee.

Members of the Corporation's staff in Nigeria attended the West African International Cotton Research Conference which was held at Samaru, Northern Nigeria, from November 19 to 23. Mr. H. L. Manning and Mr. H. G. Farbrother from the Namulonge Research Station, and Mr. M. H. Arnold from the Ukiriguru Experiment Station, Tanganyika, also attended the Conference.

The Secretary of State for the Colonies made the following written answer to a recent question in the House of Commons on Uganda cotton:

"The Agricultural Department, the Empire Cotton Growing Corporation and the Lint Marketing Board all co-operate in measures to improve the quality of Uganda cotton.

At the Empire Cotton Growing Corporation's research station in Uganda new strains of BP52 cotton have been bred which produce a higher quality yarn, and replacement of former varieties by these improved strains should be completed in the 1958-59 season. In those areas of Uganda with a harsher climate where S47 cotton is grown, existing varieties will have been replaced by improved strains with superior spinning qualities by the 1959-60 season.

The Agricultural Department treats cotton seed issued for planting against disease and supervises the buying of raw cotton to prevent the mixing of different grades.

The Lint Marketing Board encourages better ginning by the operation of the lint quality incentive scheme and by regular inspection of gineries.

An even-running staple is of advantage to the spinning industry rather than to gineries, and plant breeders in Uganda aim to improve evenness of staples. Unevenness in staple length is also reduced by dividing cotton producing areas into zones, thereby ensuring that cotton grown under differing climatic conditions is processed separately.

A Cotton Advisory Committee, which draws on all available technical knowledge, ensures that every effort is made to sustain improvement in quality."

# THE EMPIRE COTTON GROWING REVIEW

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Vol. XXXV

APRIL 1958

No. 2

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## COTTON PRODUCTION IN INDONESIA

R. R. ANSON

### **Introduction**

In January 1957 the Government of Indonesia asked the Food and Agriculture Organization of the United Nations for the services of a Cotton Specialist to determine the cotton growing possibilities of the eastern portions of Indonesia. The background to this request was firstly that one-third of Indonesia's total annual imports consisted of textiles in one form or another; a total of 100,000 tons, of which 60,000 are cotton goods. Should it be found that Indonesia could grow the cotton from which to manufacture her own textiles, it would not only diminish her external expenditure but also create large-scale employment. Furthermore, cotton might be a most useful cash crop for the schemes which were envisaged for moving excess population from certain areas to more sparsely populated regions of the Lesser Sunda Islands.

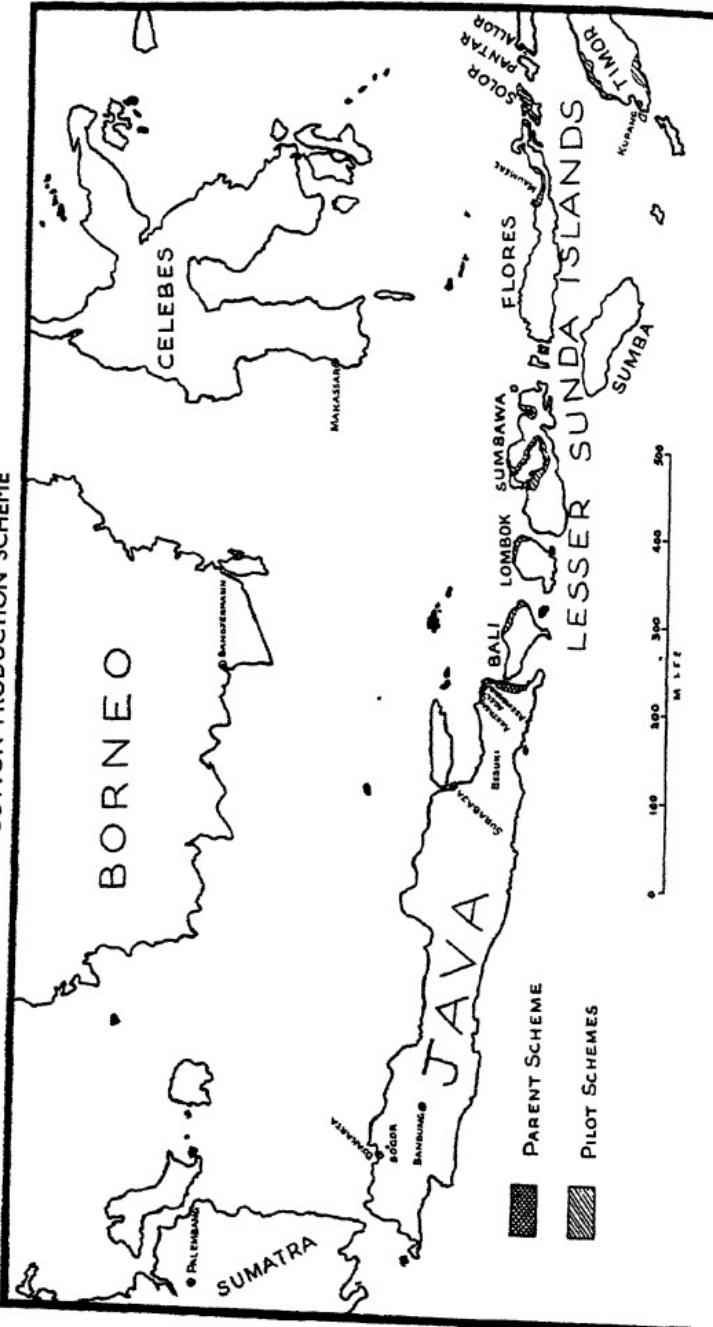
The author was assigned to the post, and between mid-February and mid-May 1957, accompanied by a member of the Agricultural Extension Service (who acted as interpreter), he toured prospective cotton growing areas on the east coast of Java and on the islands of Bali, Lombok, Sumba, Sumbawa, Flores and Timor. He also visited several cotton spinning and weaving mills in Bandung.

### **Topography and Climate**

The many thousands of islands which make the Indonesian Archipelago extend for over 3,000 miles along either side of the Equator between Asia and Northern Australia. The total area of land amounts to 735,000 square miles, with a population in 1954 of eighty-one millions.

Sumatra, Borneo, Java, Celebes, Bali, Flores and Timor are among the largest of the islands, most of which are made up of a complex string of volcanoes; there are no fewer than 400 volcanoes and 100 of these are still active. The valleys and high plains separating the volcanic mountains are covered with fertile ash and are cleverly terraced to form many thousands of small and picturesque rice fields. The mountain slopes are mainly rugged and covered with wild evergreen forests, though in some parts these have been replaced by rubber, tea, coffee and cinchona plantations. The Lesser Sunda Islands, which stretch east of Java to Timor, form the possible cotton growing areas.

EASTERN INDONESIA  
COTTON PRODUCTION SCHEME



### The Sunda Islands

In the eastern portions of most of the Sunda Islands the average rainfall is low with a marked dry season; the coastal regions are generally more arid than the interior. The soil is largely of volcanic origin with a few instances of old marine deposits. Much of the soil recommended for cotton is a red, medium light, somewhat sandy soil found on calcareous sandstone and coral, but more suitable are the grey, sandy, marly soils found in open savannah and light forest country. Some savannah areas on the hill slopes would probably grow good cotton; the chocolate-coloured soil, though rather shallow, seems fairly friable, and has a reddish sub-soil studded with many small stones over a rocky base. When cleared of forest it would erode easily and should, for this reason, be terraced or contour planted with great care.

The light forests are mostly composed of acacia, bamboo, *Thespesia*, *Zizyphus jujuba* and *Tamarindus*, with undergrowth containing *Lantana* and *Sida* intermingled with *Hibiscus*. Cotton stainer was noticed on the *Thespesia*, and the *Hibiscus* has been attacked by leaf eating beetles. Both of these pests would doubtless be troublesome to cotton growers, but greater menaces than these would be the very large and freely wandering herds of buffalo, horses, goats, monkeys and pigs.

Most of the Sunda Islands are sparsely populated, the peasants living in bamboo houses built on piles roughly 6 feet above ground level and grouped around a village square. Ninety per cent. of them practise a form of shifting cultivation which follows the firing of bush as a means of clearing. Their general crops comprise maize, millet, cassava, rice, beans, tomatoes and cotton. Permanent cultivation on irrigated terraces is found only in certain places. Their small holdings, averaging 2 acres, as well as their gardens, are protected by hedges consisting mostly of *Jatropha curcas*, Dadap (*Erythrina lithosperma*) and *Leucena glauca*. By saving labour these living barriers make for timely planting and add to the chances of a better yield. The land is used two years in succession and then abandoned, but no one may subsequently exploit it without the permission of the first cultivator, who reserves the right to return.

### History of Cotton Growing in Indonesia

Cotton has undoubtedly been grown in Indonesia for hundreds of years. The first records date back to the year 1808, when the Governor-General ordered one-fifth of the existing rice fields in areas on Java considered suitable for this crop to be planted with cotton. His scheme met with little success, however, and in 1818 Bourbon cotton was introduced, but this also failed because the climate was too wet. In 1830 both Bourbon and Pernambuco cottons were tried and, at the same time, *G. vitifolium* was introduced to south-eastern Borneo; all these trials were unsatisfactory except for one in Palembang, South Sumatra, where peasants continued to grow it. Yet another attempt was made in 1850 when a new species, possibly *G. obtusifolium*, was brought in from India. This was tried in Java, Sumatra, Celebes and south-east Borneo and proved fairly successful in Besuki, eastern Java. Cotton varieties introduced from

New Orleans later failed because of pests. In 1912 Caravonica brought in from Australia was grown first in Timor and later in Flores, and the seed cotton was sold to a firm in Makassar. In 1917 the Amsterdam Soenda Company, formed with the intention of growing better cotton, introduced seed from Egypt and America. This proved less successful than Caravonica, which was eventually distributed to the peasants. Instruction centres were also established but these efforts were never really successful, and after the first World War the Company ceased to function although the peasants continued to grow cotton.

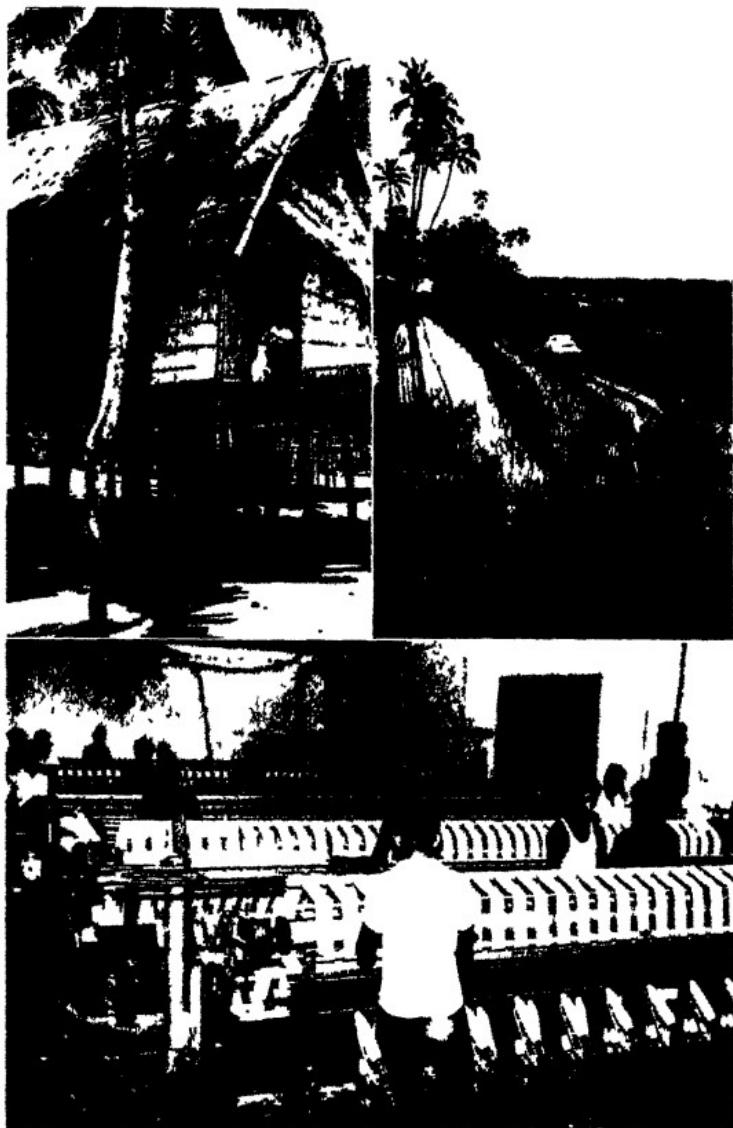
It has since been grown sporadically in many of the drier regions, principally eastern Java and on the islands east of Java. Mixed with and sometimes following crops such as rice, beans and maize, cotton is a necessary adjunct and forms an intrinsic part of the domestic requirements of the peasants. In these regions nearly every peasant woman is proficient in the arts of spinning and weaving; they thus contribute appreciably to the family wardrobe. Recently, with the object of encouraging the production of good quality cotton for internal consumption, the Government has installed an air blast saw gin of modern design at Asembagus on the east coast of Java.

At the time of the Japanese occupation (1942-45) many peasants were compelled to grow cotton commercially, and during this period the total acreage was considerable and a number of fairly modern spinning and weaving mills were introduced. Most of the records have since been destroyed, but those for the islands of Bali and Lombok indicate that yields of seed cotton of 705 lb. per acre were obtained from December plantings. Experiments carried out by the General Agriculture Experiment Station, Bogor, in co-operation with the Extension Services of the Ministry of Agriculture, have shown that of 138 varieties tested, Cambodia (*G. hirsutum*) has so far been the most successful, and on their various experiment stations in eastern Java and the Lesser Sunda Islands good yields have been obtained from it.

At Agel near Ardjasa on the east coast of Java the Agricultural Extension Service operates some small testing and inspection plots where cotton varietal trials and spacing tests are carried out. A certain amount of cotton is grown by peasants in this area. Their practice for many years has been to plant cotton in amongst other crops, mostly maize and beans, the varieties grown being Cambodia and two Asiatic species, *G. herbaceum* and *G. obtusifolium*. In some instances the cotton and other crops are planted at the same time: in others, cotton is sown between rows of maize after the maize has reached the tasselling stage. In this way the peasants obtain two crops each year from the same land. No uniform method of cotton cultivation exists; it is therefore growing throughout the year and thus encouraging pests to carry over from one season to the next.

It will be difficult to change this custom because it has been practised for a hundred years or more, but unless it is replaced by a new method designed to be less harmful to the soil, any cotton growing project launched on a large scale would probably fail and would therefore be likely to do the country more harm than good.

PLATE I



*Photographs by courtesy of Public Relations Department, Indonesia.*

*Upper left: BAMBOO HOUSE, FLORES.*

*Upper right: TERRACED RICE FIELDS, BALI.*

*Lower: TEXTILE FACTORY, INDONESIA.*



### Commercial Production

At the present time the production of Cambodia cotton for commercial purposes is negligible. The Government has done what it can to encourage production, and in 1956 the Institute of Textile Research at Bandung purchased a small quantity of lint from peasants in east Java and Timor. Samples received from first deliveries gave satisfactory results, but later deliveries were mixed, irregular and useless for commercial purposes. However, there is little doubt, that, with the introduction of modern filtering methods, plant breeders would be able to produce, from within Cambodia, a cotton resistant to jassid and bacterial blight, and giving a full  $\frac{1}{16}$  in. staple.

The most popular species grown in Indonesia by the peasants are the Asiatic cottons *G. obtusifolium* and *G. herbaceum*, known locally as "Oloe" or "Kretik." This is because their short, coarse fibres are more easily ginned by the primitive methods employed and also because, being coarse and short, the fibre becomes less tangled after teasing and thus makes a better sliver than would be the case with finer, longer stapled species. These Asiatics also ratoon more readily, are fairly resistant to pests and diseases and can persist from year to year with but little attention.

### Pests and Diseases

The danger of pest carry-over cannot be too strongly emphasized. Since cotton has been grown in Indonesia for more than a hundred years, most pests and diseases commonly found on it are well established and, because of the numerous alternate hosts growing in the forests and jungles, will be difficult to control. The following pests and diseases have been identified during the course of this survey.

**Pests:** American bollworm (*Heliothis armigera*), jassid (*Emoasca* spp.), Egyptian bollworm (*Earias fabia*), cotton stainer (*Dysdercus cingulatus*), pink bollworm (*Platyedra gossypiella*), Chinese or harlequin bug (*Tectocoris banksii*), mealy bug (*Phenacoccus virgatus*), black bug (*Lecanium nigrum*), leaf roller (*Sylepta derogata*), flea beetle (*Podagrica puncticollis*), cotton aphid (*Aphis gossypii*), blister beetle (*Mylabris pustulata*).

**Diseases:** Bacterial blight (*Xanthomonas malvacearum*), wilt (*Neocosmospora vasinfectum*), sooty mould (a casual fungus following aphid attack).

To control these pests and diseases it would be necessary to enforce a close season of at least two months, when no cotton would be grown. It would also be necessary to ensure that vigilant inspections were carried out by entomologists periodically with a view to applying controls before pest populations reached major proportions.

### Recommendations

(a) Obviously the first line of approach should be to provide a variety of cotton resistant to the pests and diseases peculiar to Indonesia and possessing a staple of suitable length and quality for the requirements of the Indonesian cotton industry.

(b) Two experienced cotton specialists, one an agronomist, the other a plant breeder, should be appointed to guide and assist the Government

in its efforts to establish a cotton industry and to train its personnel in modern methods of cotton culture and plant breeding. They should also assist in recruiting agricultural officers and demonstrators, and in training them to instruct future cotton growers in appropriate cultural methods.

(c) These experts should act in liaison with the Bogor Research Institute and the Extension Service of the Ministry of Agriculture. The plant breeder should be in charge of all cotton breeding work and bulking of pure strains. His headquarters would need to be as near Asembagus as possible and his experiment station should be sited on typical cotton growing country.

Additional testing stations and demonstration areas should be established on suitable soils in Lombok, Sumbawa, Timor and Flores. These centres would be used for bulking pure strains of cotton and for training agricultural demonstrators recruited from peasant families. Each station should be self-supporting.

(d) When instructors and practical demonstrators have been trained and are able to ensure that newly acquired land will be cultivated to its best advantage, transmigration schemes might be introduced to many sparsely populated regions of the Lesser Sunda Islands.

It is understood that as a preliminary step to implement these recommendations the Government of Indonesia has requested FAO to provide the two cotton specialists mentioned above and it is expected they will start in 1958.

#### Acknowledgments

The author is indebted to the General Agricultural Experiment Station and its Research Institute and to members of the Forests and Extension Services of the Ministry of Agriculture and the FAO-ETAP Mission in Indonesia for their kind co-operation and generous assistance.

*Received October 1957.*

# A NOTE ON A ~~MORE PRECISE~~ METHOD OF ESTIMATION OF THE UGANDA COTTON CROP

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*Empire Cotton Growing Corporation, Namulonge, Uganda*

THE planning of budgets, the provision of currency supplies, the organization of rail transport and of storage accommodation and the adequate stocking of shops with consumer goods can be facilitated in a country such as Uganda, if the size of a crop of economic importance like cotton can be estimated with reasonable precision. The Namulonge crop estimate (Manning, 1952) provides an objective assessment of the effects of acreage and planting date on crop prospects in some important cotton producing areas and is, therefore, a sound basis for forecasting. The estimate is calculated fairly early during the season and can be modified during its course by the officers of the Department of Agriculture working in the field, to provide detailed forecasts.

Three possible methods of crop estimation may be envisaged. A crude estimate may be obtained from unrevised June acreage, since this also reflects the likely benefits resulting from early planting. The sowing date and revised acreage method has already been discussed by Manning (1952). The purpose of this paper is to show how an improvement can be effected by introducing a correction for rainfall in September, October, November and December.

In recent years investigations have been initiated at Namulonge with the object of establishing a relationship between the amount and distribution of rainfall during the cotton season and the yield level. The evidence is that at Namulonge September, October and November rainfall is more important than rainfall either earlier or later in the season, because it provides moisture in the soil during the critical stage of early boll development, coinciding as it does with the time of rapid expansion in leaf area (Hutchinson *et al.*, 1957). This relationship was indicated in 1954 when poor rains in October and November were followed by a very poor crop. The drastic curtailment in crop prospects between September and November that year was not reflected in forecasts of crop size until very much later, and there was then naturally a tendency to relate the shortfall to immediate circumstances, and not to the real cause some months previously.

It is probably for this same reason that attention has hitherto been devoted more to the extent of the late rains and their relation with the Protectorate crop. In fact, in 1955-56 seasonal rains were invoked both to justify an optimistic view of the crop situation ("The general effect of the rain in December was to benefit the later planted crop but to lower the grade of the already opened cotton." Cotton Report, Dec. 1955) and to account for a reduction in the crop estimate ("The wet weather in the main producing areas of the country was deleterious to the crop and it is now unlikely that the previous estimate of 365,000

bales will be reached." Cotton Report, Jan. 1956). There is no doubt that heavy rains, when the bolls are opening, are deleterious to the crop, since they may be such as to prevent picking, or to beat out the open cotton on to the ground. Nevertheless, it may be argued that such conditions are local in incidence and though they may be serious for individual farmers the statistical evidence indicates that they do not have a very large effect on the crop as a whole.

Comparing 1954-55 and 1955-56, it is interesting to note that the initial Departmental estimates were about the same (360,000-365,000 bales), and in both years similar December rains were believed to have helped the late crop, and January rains to have reduced the yield prospects. Yet in 1954-55 only 300,000 bales were reaped and in 1955-56 the lint produced amounted to 363,000 bales. The conclusion is unavoidable that late rains (Dec.-Jan.) have in fact little effect on crop prospects.

The significance of September-November rains and the insignificant effect of December and January rains are borne out by data from Namulonge. In Table 1 are given rainfall totals for September-November and for December-January together with yields of early and late planted crops in farm bulks for the years 1950-51 to 1955-56. It will be seen that the order of yields of the late sown cotton followed closely the rainfall totals received from September to November and was quite unrelated to the December-January rainfall. Yields of early planted cotton, on the other hand, were very little altered by rainfall during the cropping period except in 1954-55, when the total September to November rainfall was as low as 5.38 in.

TABLE 1.—CRITICAL RAINFALL AND COTTON YIELDS AT NAMULONGE  
1950-51 TO 1955-56

	Rainfall (in.)		<i>Sown June 16-30 lb./acre</i>	<i>Sown Aug. 1-15 lb./acre</i>
	<i>Sept. to Nov.</i>	<i>Dec. and Jan.</i>		
1950-1	12.47	4.77	961*	474
1951-2	17.97	6.97	1,163	831
1952-3	7.79	1.66	983	562
1953-4	15.70	6.62	975	756
1954-5	5.38	10.49	429	281
1955-6	10.12	8.00	1,095	581

\* *Sown June 1-15*

Acreage and planting date records are now available for a much greater proportion of the cotton area than was considered by Manning (1952), and it is therefore possible to base the Protectorate estimate on more comprehensive information. In an attempt to improve the precision of the estimate, the relationships between crop sizes and rainfall, both before and during the cotton season, have been examined in detail for each of the main cotton growing districts of the Protectorate.

The following statistically significant relationships have been demonstrated:

- Mengo-Entebbe: Parabolic relation with October November rainfall.
- Masaka: Parabolic relation with April May pre-sowing, rainfall.
- Busoga: Linear negative relation with May June (pre-sowing, rainfall. Linear positive relation with October to December rainfall.
- Mbale: Linear positive relation with September to November rainfall.
- Lango: Parabolic relation with October to December rainfall.

Attention was drawn to the importance of September-November rain by Manning (1952), but at that time no satisfactory single figure representative of the rainfall of a large area such as Mengo-Entebbe had been devised and no use, therefore, could be made of the knowledge to improve the crop estimate. Rainfall indices have now been devised which can be included in multiple regression analyses for the estimation of crop sizes. To obtain the indices rainfall recording stations with a sufficiently long run of figures were selected for each district, preference being given to stations representing areas growing a large acreage of cotton. Rainfall data from the stations were averaged for each year, and these average figures were plotted against relevant crops and regressions calculated. The stations used for each region are listed in Appendix I. In the case of linear regressions, whether positive or negative, these actual data are incorporated in the multiple regression analyses. Where the relationship is parabolic, then the differences between individual values and the optimum rainfall index calculated from the same parabola are used. When these differences are plotted against relevant crops on a graph with their signs ignored the relationship is reduced to a linear negative trend. By this device a rainfall index with a parabolic relationship can be included in a multiple regression. The introduction of a rainfall index into the estimation of the Mengo-Entebbe crop necessitated the use of a smaller number of seasons because from the majority of suitable rainfall recording stations in the ten Mengo-Entebbe counties there are not more than sixteen or so years' run of records. A reduction in the number of seasons meant reduction in the degrees of freedom and also a reduction in the amount of variation that can be accounted for. As a result  $R^2$  for Mengo-Entebbe has dropped from 0.800 to 0.753. For Busoga, however, where pre-sowing and post-sowing rainfall indices have been introduced,  $R^2$  has improved from 0.354 to 0.728. For Masaka an April and May rainfall index has always been used in estimating the crop. For Mubende no rainfall index is worth while. Here it is only necessary to have an accurate estimate of acreage. The linear regression of crop size on acreage accounted for 54 per cent. of the variation in the crop.

## PROTECTORATE CROP

Crop estimates have for some years been made for Mengo-Entebbe, Masaka, Mubende and Busoga and the total of these has been used in a suitable regression for the estimation of the Protectorate crop. The precision of this estimate is discussed by Manning (1952). During the last few years there have been changes in some of the major cotton areas of Uganda. In Buganda, cotton acreages and lint produced have decreased considerably to give way to increases in coffee acreages. On the other hand, in the S47 area there have been large increases in cotton production. These changes have shifted the balance slightly and reduced the precision of the estimate of the Uganda crop. To attain a fair level of accuracy in the estimation of the Uganda crop it is important to obtain reasonably precise crop estimates for all or nearly all the main producing districts. Then the inclusion of climatic factors such as rainfall along with acreage and planting date offers a considerable advance over the original method involving acreage and planting date only.

In crop estimation for any district in Uganda the most important factors contributing to crop variation are expected to be acreage and planting date where this is applicable. For acreage this linkage should be universally true; it is plotted for the main cotton growing areas of the Protectorate in Figs. 1 to 3.

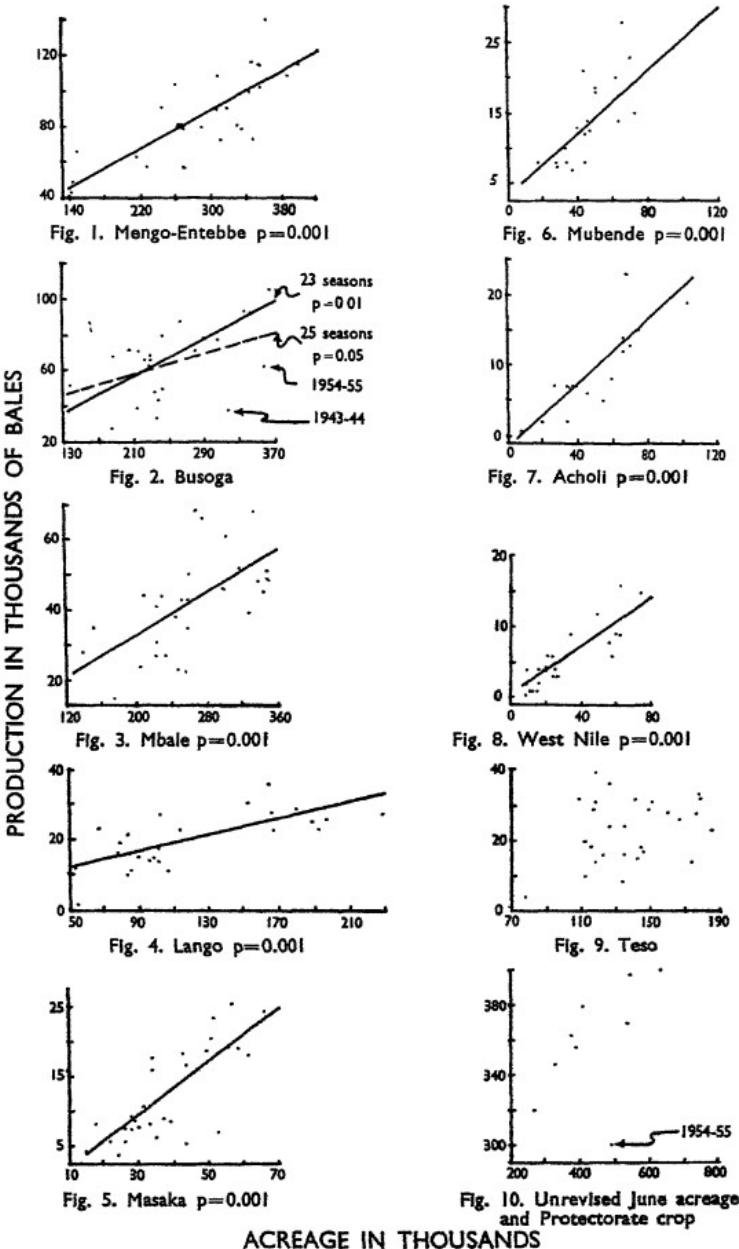
Mengo-Entebbe, Busoga and Mbale are by far the largest single producing areas. At the same time the relationship is shown to hold for the smaller areas (Figs. 4 - 8), in which doubtless production is vitally important to these individual areas, but of which the contribution to the Protectorate as a whole is of no great significance. In Busoga, however, the relationship, although statistically significant ( $p = 0.05$ ), is regarded as a poor one and it can be shown graphically that the fit is not very good while the partial regression for acreage only accounts for 19 per cent. of the variability.

If, however, two seasons are omitted, namely 1943-44, in which there was a famine in the second half of the year, and 1954-55 in which the October-November rains failed, the estimate based on 23 instead of 25 seasons gives a more rational relation between acreage and production. The value for  $R^2$  (0.493) in Table 2 is that based on the 23 years. The  $R^2$  based on all 25 years was 0.186, and the regression line was such that when projected to zero acreage a crop of nearly 26,000 bales was predicted. The relationship based on 23 years gave a crop at zero acreage of about 1,000 bales. Thus the relationship based on 23 years gives a reasonable prediction over the range from 0 to about 360,000 acres, the figure for zero acreage not being significantly different from zero bales. The graphical presentation (Fig. 2) also demonstrates some degree of improvement as regards the slope of the regression line.

This step is not new, for it will be noticed that in the estimation of Mengo-Entebbe crop seasons, 1934-35 to 1938-39 were also omitted for the reasons given elsewhere (Manning, 1952). Further, in a sample with a small population as in this example, one or two values, widely

ESTIMATION OF UGANDA COTTON CROP  
RELATIONSHIPS BETWEEN ACREAGE AND PRODUCTION

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divergent from the rest, can introduce variability of such magnitude that the otherwise good relationship between two variables is altered considerably. This is a fair demonstration of the case in point.

In Teso (see Fig. 9), when all seasons are used to determine the relationship between the crop and acreage, no statistical relationship can be demonstrated. Apparently in Teso there are factors affecting yield per acre of such magnitude that the effect of acreage on crop size is masked.

The regression coefficient and values for  $R^2$  (coefficient of determination) for the data of Figs. 1 to 8 are summarized in Table 2. The precision of these regression analyses is shown by the relatively high values for  $R^2$ . Even the poorest, Mbale ( $R^2 = 0.398$ ), has a correlation coefficient of +0.63.

TABLE 2.—REGRESSION OF PRODUCTION ON ACREAGE ALONE FOR THE GIVEN DISTRICTS

District	" <i>b</i> " values	$R^2$
Mengo-Entebbe ..	0.2779	0.667
Busoga ..	0.2666	0.493
Masaka ..	0.3806	0.595
Mubende ..	0.2216	0.543
Mbale ..	0.1514	0.398
Lango ..	0.1225	0.543
Acholi ..	0.2297	0.734
West Nile ..	0.1755	0.771

A significant dependence of crop size on sowing date has been demonstrated in Mengo-Entebbe, Masaka, Busoga, Mbale and West Nile. Sowing date has had little effect in Mubende, Teso and Acholi. For the future, crops of the following districts will be estimated: Mengo-Entebbe, Masaka, Mubende, Busoga, Mbale, Lango, Acholi and West Nile; and a total of the estimated crops from these areas will be used to estimate the Protectorate crop.

In Table 3 are given algebraic formulae for crop estimation for these districts. Estimated and actual crops for the 1956-57 season are given. From a regression analysis involving the total actual crop from the above districts and the Protectorate crop a close relationship is

TABLE 3.—REGRESSION EQUATIONS FOR THE CALCULATION OF DISTRICT CROP ESTIMATES

District	<i>k</i>	000 acres	$\bar{x}_s$	$x_s$	$x_s$	$x_s$	1956-57	actual
			mean sowing date	coded pre- sowing rainfall	coded post- sowing rainfall	estimated production 000 bales		
Mengo-Entebbe ..	109.228	+0.2133	-21.2750	—	-4.9796	88.280	90.295	
Masaka ..	13.342	-0.2961	2.9781	-0.0851	—	4.430	7.003	
Mubende ..	0.470	-0.2744	—	—	—	18.300	16.031	
Busoga ..	*129.732	+0.0912	-15.6449	-4.6809	+0.8748	94.820		
Mbale ..	111.574	+0.0845	-10.1658	-4.9367	+1.0945	89.100	106.200	
Lango ..	41.814	+0.0988	-14.9130	—	+1.8739	51.896	48.641	
Acholi ..	9.600	+0.1144	—	—	-1.4207	26.060	26.358	
West Nile..	-1.680	+0.2297	—	—	—	19.980	17.450	
	8.204	-0.1860	-2.2870	—	—	13.730	11.543	

\* Excluding 1943-44 and 1954-55 (see text).

demonstrated giving an  $R^2 = 0.989$  and it is from this analysis that we get the formula for the Protectorate crop as given below. In the 1956-57 season the total of the estimated crops for the eight districts amounted to 307.8 thousand bales. An estimate of the Protectorate crop can then be obtained by substituting that total in the equation:

$$Y_E = 1.1335x - 6.26$$

giving an estimate of 342.6 thousand bales with the likelihood of not falling below 323.6 thousand or exceeding 361.6 thousand more often than once in 20 times. Actual production was in fact 369,593 bales in the season, which was above the 19 : 1 upper limit. It will be seen that the greater part of the discrepancy resulted from a large excess of production over the estimate in Busoga. If the prediction formula based on 23 seasons only for Busoga were used, it will be seen that the crop was expected to be about 95,000 bales. Substituting this value gives an expected total for eight districts of 313,500, which in the regression formula above indicates a Protectorate crop of 349,100. With approximately the same error the range would be 330,000 to 368,000 bales.

The crude estimate to which reference was made earlier may now be considered. When the Protectorate unrevised cotton acreage planted in June is plotted against the crop over a range of the last eight seasons a positive linear trend is demonstrated. The 1954-55 season is omitted because as shown in Fig. 10 it does not fall in with the rest of the points as a result of the poor October-November rains in that year. The relation from this graph can be put to use for the sake of obtaining a rough preliminary estimate of the Protectorate crop early in the cotton season.

#### SUMMARY

It is suggested that in future the estimation of the Uganda cotton crop may be made in three stages.

- (a) A preliminary estimate may be based on the unrevised estimate of acreages planted up to the end of June. Since this relationship is based on eight seasons' data only, it should be accepted with some reserve.
- (b) A revision of the first estimate may be made as soon as revised data for acreage, sowing date and pre-sowing rainfall are received. These revisions are usually available during the latter part of October.
- (c) The final estimate will be made when the post-sowing rainfall data are available.

The actual working of these three estimates for the season 1956-57 is set out, together with the crop realized, in Appendix II.

#### ACKNOWLEDGMENTS

The writer is indebted to the Department of Agriculture, and particularly to Mr. J. D. Jameson, for making the crop data available to him; to the East African Meteorological Department for the supply

of rainfall data; to Sir Joseph Hutchinson, C.M.G., F.R.S., and Mr. H. L. Manning for their interest and advice during the preparation of this paper.

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## APPENDIX I

Rainfall averages for the different districts were computed from the following rainfall recording stations. Indices for the 1956-57 season are given in brackets.

(a) <i>Mengo-Entebbe</i>	(b) <i>Masaka</i>
Bukalasa	Masaka
Kalagala	Bikira
Kawanda	Kalungu
Mukono	Kyanamukaka
Kabasanda	Period: April/May.
Nkozi	Number of years: 28.
Maddu	Relation: parabolic.
Gayaza	Indices obtained as in (a).
Ngogwe	(72 to one decimal place and multiplied by 10).
Nagoje	
Ntenjeru	
Period: Oct./Nov.	
Number of years: 17.	
Relation: parabolic.	
Indices obtained from differences between optimum average value and each value with signs ignored. (1.48 to 2 decimal places).	
(d) <i>Mbale</i>	(c) <i>Busoga</i>
Kibale	Namasagali
Bukedea	Iganga
Budumba	Vukula
Butaleja	Jinja
Tororo	Bulopa
Debani	Bugaya
Nagongera	Periods: (i) May/June (pre-sowing). (ii) Oct./Dec. (post-sowing).
Mbale	Number of years: 25.
Period: Sept./Nov.	Relations: (i) Linear negative. (ii) Linear positive.
Number of years: 26.	Average values were used: (pre-sowing: 7.85) (post-sowing: 10.17) (To 2 decimal places).
Relation: linear positive.	
Average values were used. (11.20 to 2 decimal places).	
(e) <i>Lango</i>	
	Kaberamaido
	Aduku
	Ngetta
	Atura Port
Period: Oct./Nov.	
Number of years: 26.	
Relation: parabolic.	
Indices obtained as in (a). (0.04 to 2 decimal places).	

## APPENDIX II

## STAGES OF ESTIMATION FOR THE 1956-57 CROP

## Stage 1:

June unrevised acreage: 541,320  
 Crop estimate: Roughly 387,000 bales

## Stage 2:

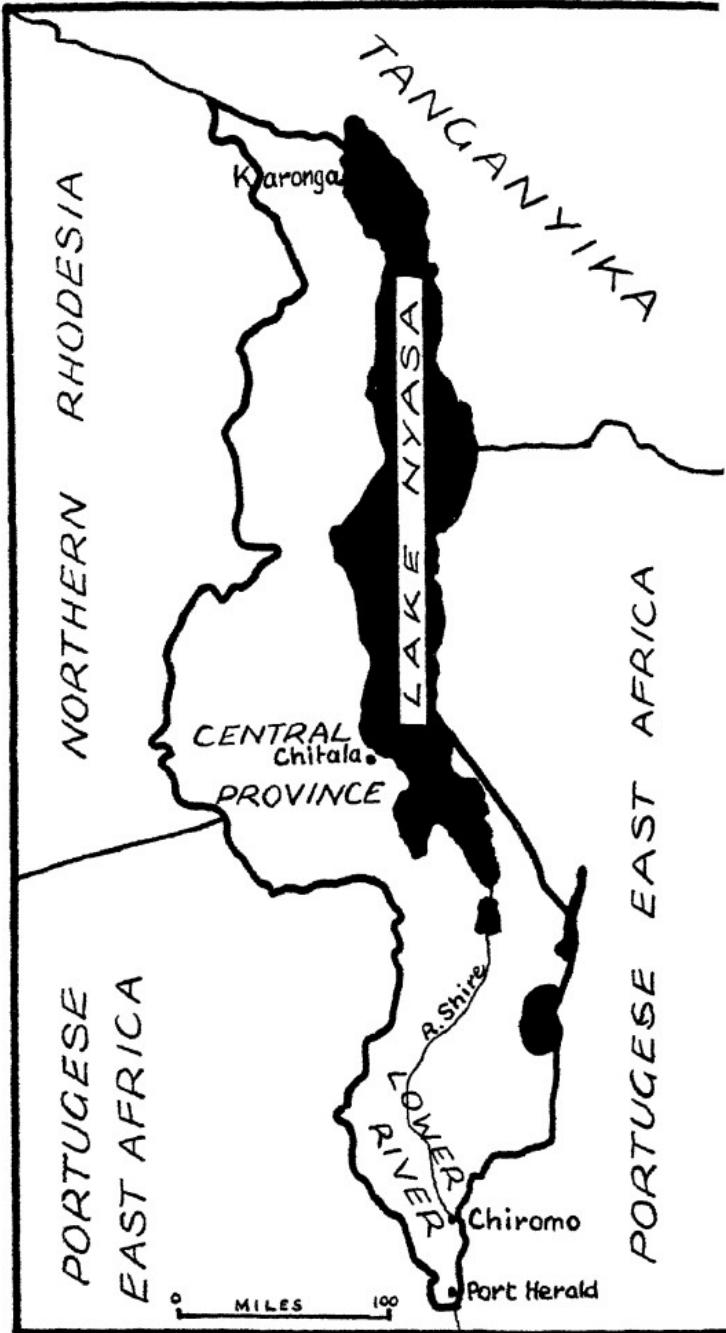
Mengo-Entebbe:	$109.228 - (0.2133 \times 258.1) - (21.2750 \times 3.32)$
	= 93.648
Masaka:	$13.342 + (0.2961 \times 27.9) - (2.9781 \times 3.71) - (0.0851 \times 72) = 4.427$
Mubende:	$0.470 + (0.2744 \times 57.66) = 16.292$
Busoga:	$128.732 + (0.0912 \times 364.1) - (15.6449 \times 2.51) - (4.6809 \times 7.85) = 85.924$
Mbale:	$41.814 + (0.0998 \times 313.5) - (14.9130 \times 2.83)$
	= 30.897
Lango:	$9.600 + (0.1144 \times 144.4) = 26.119$
Acholi:	$-1.680 + (0.2297 \times 94.3) = 19.981$
West Nile:	$8.204 + (0.1660 \times 75.3) - (2.2870 \times 3.05)$
	= 13.729

The total of the estimated crops for the above districts amounts to 291.017. Therefore the estimated crop for the Protectorate at this stage amounted to  $1.1335 \times 291.017 - 6.26 = 323.6$  thousand bales.

	Production	
	Estimated	Actual
Stage 3:		
Mengo-Entebbe:	93.648 - (4.9796 $\times$ 1.48) ..	86.278
Masaka:	— ..	4.427
Mubende:	— ..	16.292
Busoga:	85.924 + (0.8748 $\times$ 10.17) ..	94.821
Mbale:	30.897 + (1.8739 $\times$ 11.20) ..	51.885
Lango:	26.119 - (1.4207 $\times$ 0.04) ..	26.062
Acholi:	— ..	19.981
West Nile:	— ..	13.729
		11,543

Received January 1958.

NYASALAND AND SURROUNDING TERRITORIES



# THE SUMMER CROPPING REGIME IN THE LOWER RIVER, NYASALAND

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TRUE summer cropping of cotton was introduced in the Lower River in the 1951-52 season. From that year late planting has been prohibited, and a close season has been established from July 31 to November 15. Planting and uprooting dates are compared in the following table:

	Type of crop	Planting	Harvesting	Uprooting
Before 1952 ..	Semi-summer	Jan.-Feb. Mar.-Apr.	July-Oct. Sept.-Oct.	Oct. 31 Oct. 31
Since 1952 ..	Winter Summer	Nov. 15-Jan. 7	Apr.-July	July 31

This change was made to control the damage caused by red bollworm, and was one of the alternatives recommended by Pearson and Mitchell (1945). The history of events leading up to the change is recorded by Ducker (1951).

The results of the change as measured by total seed cotton production in the Lower River have been disappointing. Average production has increased by 761 tons, an increase of only 18 per cent. (Table 1). Doubts have been expressed as to whether the change has been worth while, and this note is an attempt to collect all the relevant information available,

TABLE 1.—PORT HERALD AND CHIKWAWA DISTRICTS

Year	Seed cotton purchased (short tons)	Grade 2 %	No. of growers	Seed cotton	
				per grower	lb. per acre
1945 .. .. ..	3,594	20	30,503	236	
1946 .. .. ..	3,776	26	28,532	265	
1947 .. .. ..	5,147	5	28,439	362	
1948 .. .. ..	6,793	19	39,190	347	
(1949 .. .. ..	831	11	20,561	81)	
1950 .. .. ..	5,327	15	35,664	299	
1951 .. .. ..	1,572	6	26,899	117	
Mean (excluding 1949)	4,366	15	31,538	271	
1952 .. .. ..	5,778	10	20,072	576	486
1953 .. .. ..	7,403	20	21,074	703	418
1954 .. .. ..	5,103	19	24,257	421	373
1955 .. .. ..	6,713	31	28,452	472	372
1956 .. .. ..	2,183	44	19,654	222	193
1957 .. .. ..	3,582	25	17,519	409	397
Mean .. .. ..	5,127	25	21,838	467	373

and to examine some of the arguments for and against the present régime. It may as well be admitted from the start that the statistics collected have proved of little help in this examination, as they can be interpreted in various ways.

We now have six seasons' records since 1952, so I have taken for comparison six years before 1952, omitting 1949; this was an exceptional year of drought over much of Africa.

#### **Red Bollworm**

The summer cropping régime has resulted in considerable control of red bollworm. There are no population records to compare with those of 1939-44, but observations in the past two seasons, and records made in 1956-57 on and around the Makanga Station 3 miles north of Chiromo both support this conclusion. Pearson (1957), comparing the position in June 1956 with that in 1939-44, concluded that "the new régime in the Lower River is giving sufficient control of red bollworm to permit the setting of a very large potential crop." Production per grower has increased by 75 per cent. and yield of seed cotton has averaged 373 lb. per acre since 1952, quite a satisfactory figure for African-grown cotton.

#### **Mixed Cropping**

Rapid growth and early setting of the crop were considered essential to the success of the new régime. Intercropping of cotton with maize and bulrush millet was the practice when much of the crop was grown on seasonally flooded land, and survived the move to dry land cultivation when the Lower River marshes were permanently flooded. As this practice delayed the growth of cotton it was prohibited when the change to summer cropping took place, and since 1952 cotton has been grown in pure stand only. This has also resulted in a much better standard of cultivation, and has contributed to the higher yields obtained.

Dry land cotton dependent on rainfall gives its best yield when planted early. In mixed cropping, cotton was invariably planted after the maize had been established; the closer together the planting dates, the more deleterious was the effect on the cotton. Early planting was therefore impossible with intercropping, and the crop harvested in the extra three months to October 31, often negligible, was not sufficient even in a season of late rains to make up for late planting. Only on seasonally flooded land can late planting hope to compete with early planting.

#### **Grade 2 Cotton**

From 1952 to 1956 Grade 2 cotton increased from 10 per cent. to 44 per cent. of the total bought; in 1957 it was 25 per cent. Observations in the last two seasons indicate that this is mainly the result of increased damage by cotton stainers, and the question arises whether this increase is due to the change in the planting season.

The percentage of Grade 2 cotton bought is a reflection of the amount of stainer damage, but cannot be accepted as more than an approximate

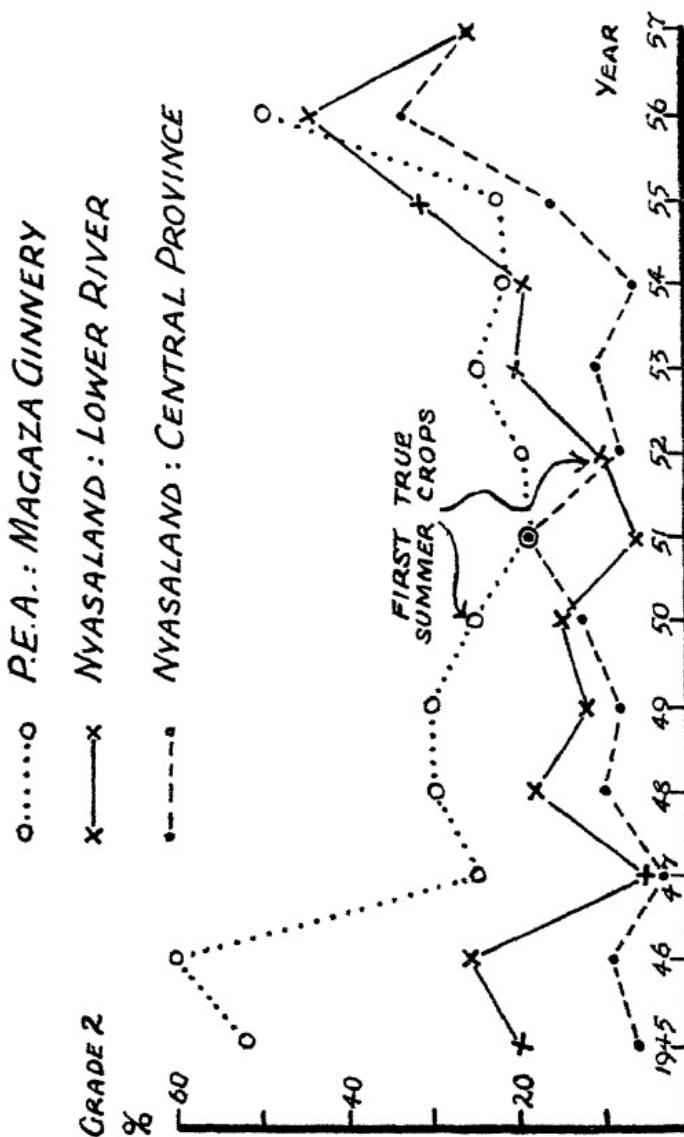


FIG. 1.—PERCENTAGE OF GRADE 2 SEED COTTON PURCHASED

measure. It is affected by the prices offered for the two grades; a varying amount of Grade 2 cotton is left unpicked in the field; many bolls damaged at an early stage never produce any pickable cotton; and other pests and diseases are responsible for an unknown proportion of the damage. In the absence of stainer records, however, the percentage of Grade 2 is the best measure of stainer damage that we have over the thirteen-year period.

There appear to be two independent factors affecting stainer damage. Cotton under the new régime is carrying its first crop of green bolls in March, when the stainlers are leaving their main alternative host, *Sterculia africana*, and some of the increase in stainer damage can be ascribed to this factor. Stainer breeding, on the other hand, depends on climatic factors, particularly moist soil conditions for hatching and survival of the young nymphs. Late rains encourage stainer breeding in the cotton crop.

Fig. 1 compares the Grade 2 percentage in the Lower River and the Central Province. As a working hypothesis, the correspondence between the two curves can be attributed to generally similar climatic conditions for breeding; the higher average in the Lower River throughout the thirteen-year period can be attributed to differences in the relationships between cotton and the wild stainer hosts in the two areas; and the residual difference before and after 1952 to the effect of the new régime in the Lower River. On this hypothesis the average increase of 7 per cent. since 1952 in the Central Province, where summer cropping has been generally practised since before 1945, measures the effect of climatic factors, and the additional 3 per cent. increase in the Lower River is due to the new régime.

Just across the Shire river the Portuguese introduced early planting and uprooting in 1950, two years earlier than in Nyasaland; any increase in the percentage of Grade 2 cotton due to the change in planting season should have occurred two years earlier in Portuguese territory. The Centro de Investigação Científica Algodoeira has very kindly supplied Grade 2 figures for the Zambezi Province; those from Magaza ginnery adjacent to Port Herald are shown in Fig. 1. After the change in planting dates, no increase in the percentage of Grade 2 cotton occurred until 1956.

### Ginning Percentage

Since 1952, the commercial ginning percentage has averaged about 2 per cent. less in the Lower River than before. This appears to be a direct result of the change in planting season; the Chiromo ginnery records show that there is a steady rise in the monthly ginning percentages for Grade 1 cotton from under 28 per cent. in April to over 32 per cent. in October. The figures obtained before and after 1952 agree in showing similar rises from month to month (Munro, 1958).

An increase of 7 per cent. in seed cotton is required to compensate for a 2 per cent. reduction in ginning percentage, apart from extra handling and ginning costs.

### **Production per Grower**

The success of a new cropping policy is usually measured by yield per acre. In the present case, the simultaneous change from intercropped to pure stand cotton makes it impossible to estimate the effect of bollworm control by this means. An alternative measure is the production per grower. Unfortunately the accuracy of the number of growers reported each year is open to question. The number is estimated in two ways: in the first instance a count is made of the first issues of seed to growers from each store, and later a garden census is taken during the growing season. Both these methods are subject to considerable errors, and it is not always certain which method has been used. The figures will, however, indicate major changes from year to year.

The production per grower rose substantially after 1952, but this increase has been largely offset by a reduction in the number of growers. This appears inconsistent; it is unlikely that the grower would increase his production if the crop was not profitable; on the other hand, if yields have increased, why have more growers not taken to cotton?

Explanations of this inconsistency are at present largely a matter of speculation, but it is probably the key to the absence of any substantial increase in production. It may be argued that the new régime has introduced competition between cotton and food crops at planting and harvest time; that the smaller and less efficient growers have gone out of production; that growers have been discouraged by strict enforcement of the cotton rules; that uprooting by July 31 is unpopular, especially when the plants are carrying green bolls; that economic incentive is lacking; and so on.

It is worth noting, however, that the numbers of growers showed a steady increase up to 1955. The drop in 1956 was largely due to very difficult planting conditions; in north Chikwawa the first rains came in January. The poor yields in 1956, in which the heavy stainer attack played an important part, probably discouraged many people from planting cotton in 1956-57.

### **Discussion**

The lack of conclusive evidence in favour of the summer cropping régime certainly does not mean that it has been a failure; there is an equal lack of evidence that things were better as they were.

There has been a drop in ginning percentage, and an increase in stainer damage; but a substantial part of the latter can be attributed to climatic factors. On the other hand, the production per grower has increased by over 70 per cent., and total production has increased in spite of heavy stainer attacks in 1955 and 1956. Unfortunately, it remains an open question how much of this increase is due to bollworm control, pure stand cotton, early planting, more extension staff, better marketing and better prices. It may be mentioned here that pure stand cotton would not have been introduced without early planting; it was expected to be one of the main difficulties in the changeover.

Any relaxation in the present summer cropping régime would be a

serious danger to the Lower River cotton crop. Red bollworm control now shows a marked contrast to the position in the Central Province, where production has fallen from an average of 1,200 tons of seed cotton per annum to under 200 tons, largely because of red bollworm. The intensity of the attack there is a recent development; as recently as 1952 Ducker (1952) reported that "the close season . . . in all areas . . . has resulted in a good control of red bollworm. Experience at the Cotton Research Station, Chitala, suggests that this can be maintained indefinitely. . . ." In 1955 the position had changed considerably. ". . . In the central areas represented by Chitala, the close season measures at present in use do nothing appreciably to control the ravages of red bollworm" (Ducker, 1955).

The red bollworm is not easy to control, even with the use of insecticides. Rather than lose the ground already gained, the Department of Agriculture is concentrating on methods of controlling stainlers, which may prove vulnerable on their wild host trees. Control of these two major pests is essential for sound development of cotton production in the Lower River.

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*Received January 1958.*

#### DR. J. C. WILLIS, F.R.S.

AS THIS issue goes to press, news has been received of the death at Montreux on March 21 of Dr. J. C. Willis, F.R.S. Dr. Willis was born in 1868, and after studying at Liverpool and Cambridge held the Directorship of the Botanical Gardens in Ceylon and subsequently Rio de Janeiro. He was appointed Editor of the *Empire Cotton Growing Review* when it first appeared in 1924, and served in that capacity with distinction until the outbreak of war in 1939. Among the publications for which his name will be remembered is his *Dictionary of Flowering Plants and Ferns*, first published in 1897 and reprinted on many occasions, the last as recently as 1957.

## A NOTE ON COTTON INSECTS IN BRITISH GUIANA

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COTTON, formerly exported in considerable quantities, passed out of cultivation in British Guiana after the abolition of slavery, and except for a brief period during the American Civil War has not since been grown commercially. Several attempts have been made to revive the industry and investigations have been conducted into the technical difficulties involved in growing cotton.

In 1955 an officer was appointed to undertake a further investigation, and it soon became clear that insects would be of some importance on any commercial crop. A study was therefore made of insects occurring on the crop to determine whether there were any which would have to be controlled on commercial cultivations and if so whether economic control appeared to be feasible.

At that time the lack of adequate research facilities on a station of suitable size imposed certain limitations on the manner in which the investigation was made. The plots were scattered, and the lack of experienced men to supervise the work on them precluded any replicated experimentation or counting procedures. All insecticide investigations were therefore purely observational. Notes on the main species found on cotton are given below.

### ✓ *Dysdercus* spp.

Three species of *Dysdercus* have been recorded from cotton in British Guiana, namely *D. fuscofasciatus* Blöte,<sup>2</sup> *D. howardi* Ballou<sup>4</sup> and *D. ruficollis* L.<sup>3</sup> *D. maurus* Dist. and *D. mimus* Say are known from *Malachra capitata* in British Guiana (specimens collected by L. D. Cleare, 12 v. 1930), but not from cotton, from which, however, they have been recorded in Trinidad.<sup>4</sup> The species that is most important on cotton in British Guiana is that locally regarded as *D. ruficollis*, but its true identity appears doubtful, and it may well be the continental form of *D. howardi* that has been recorded from British Guiana.<sup>4</sup>

The host plants of *Dysdercus* in the West Indies have been discussed by Squire,<sup>5</sup> and species of the following genera, stated to include hosts of *Dysdercus*, are recorded in the Georgetown Herbarium as occurring in British Guiana: *Ceiba*, *Hibiscus*, *Thespesia*, *Sida*, *Malachra*, *Sterculia* and *Pachira*. *Dysdercus* has been seen breeding particularly on *Ceiba pentandra* and *Malachra capitata*.

During the investigation, two cotton crops were taken in the year, corresponding to the two dry seasons. The spring crop was sown in November and picked in March-April, while the autumn crop was sown in May and picked in September-October. Stainers moved into the

cotton later, and were less serious on the spring than on the autumn crop. Observations made on a plot of perennial cottons suggested a periodicity in the numbers of stainlers, related to seasonal variations in rainfall, which appeared to reduce the stainlers' rate of increase. The spring crop followed closer upon the heels of the rains than did the autumn crop, which was picked in the longer of the two dry seasons, and the apparent effect of rainfall in reducing the rate of increase may be the reason why the stainlers appeared later and did less damage on the spring than on the autumn crop. Light intensity and changes in humidity and temperature are involved in the possible effects of rainfall, but *D. howardi* in Trinidad is stated to be more active in the full heat of the sun than in the early morning or during dull weather.<sup>1</sup>

✓ Only on very small plots did stainlers ever fail to appear, and it seems certain that any large areas of cotton in British Guiana would suffer damage from stainlers, and that the damage suffered by the autumn crop would be particularly severe.~

✓ It appears improbable, with the great areas rich in wild hosts which would surround any cotton-growing area, that *Dysdercus* could be controlled by the enforcement of a close season and the elimination of wild hosts. The varietal aspect of stainer control would clearly be to sow early maturing varieties with a high rate of flowering, and cultural practices should aim at throwing the cropping period forward.

During the earlier stages, at least, of commercial cotton cultivation in British Guiana, insecticides would be necessary against stainlers. Trials were therefore conducted to determine a satisfactory dusting routine for use by peasant farmers. The trials indicated that under conditions of heavy infestation where immigration from wild hosts occurred throughout the critical stage of the crop, control was secured by dusting with 0·65 per cent. gamma BHC at 75 lb. per acre, under favourable conditions of wind and dew. To secure good control throughout the cropping period, four applications at ten-day intervals were necessary.~

To recommend this as an invariable routine would very often commit the farmer to more dusting than was necessary, but the number and timings of applications could hardly be left to the judgment of the farmer himself until he had acquired considerable, possibly costly, experience of the problem. The possibility of a dusting being nullified by "unseasonable" rainfall is a further disadvantage in the practical adoption of such a routine.

Trials were therefore conducted using low-volume spraying, a "Motoblo" shoulder-mounted air-blast spraying unit being employed. It was possible to conduct trials with only one insecticide, viz. dieldrin, before the investigation ended, but interesting results were obtained. An emulsion of  $\frac{1}{2}$  pint dieldrin 20 per cent. emulsion concentrate in 2 gallons of water, applied at 3 gallons per acre, gave good control of stainlers over a 6-acre plot of perennial cottons of very diverse habit, and stainlers did not reappear on the plot for a month. In wet weather low-volume spraying would be more economical and more persistent than dusting, and any large-scale cotton cultivation in British Guiana would almost certainly depend upon it for protection against stainlers.

Such a method would also remove the onus of stainer control from the farmer, as spraying would have to become the responsibility of some central organization.

#### *Empoasca* sp.

Specimens of the jassid found on cotton were identified by Mr. D. A. Young (through the U.S. Department of Agriculture) as *Empoasca* sp. near *coturnula* Young. It appears to be the most important pest attacking cotton in British Guiana before flowering, and causes typical and conspicuous leaf symptoms. Larger plots became more heavily infested than smaller ones, poor weeding encouraged infestation, and throughout, well-grown cotton was the most heavily infested. Of the varieties examined, there appeared to be little to choose in jassid susceptibility between Sea Islands, Coastland, Sudan types, Tanguis and the American Uplands, but the African Uplands were resistant.

The difficulty of relating leaf damage to yield made it impossible to assess the importance of jassids, and yield experiments could not be performed. Nevertheless, trials were conducted on insecticidal control, using dusts, and high-volume and low-volume sprays. It was necessary to employ some relatively simple method of assessing the jassid population, and the method used was for the recorder to make a number of counts of the adults seen while making slow transects across the plot for a period of five minutes.

DDT dusts proved unsatisfactory, but sprays were effective at 1 lb. technical DDT per acre applied in an emulsion at 75 gallons per acre. Good under-leaf coverage was necessary, however, and spraying was laborious and slow. Low-volume application of dieldrin emulsion using the "Motoblo" unit was successful, 0.58 lb. technical dieldrin per acre applied in an emulsion at 19 gallons per acre greatly reducing the jassid population for a month. A higher dosage, however, appeared to be needed to secure adequate under-leaf coverage at a later stage of growth. Low-volume application clearly needed an operator more skilled than the usual to be successful.

#### Other Pests

*Nezara viridula* L. was seen on cotton in four successive crops but never in any numbers, and caused no appreciable damage. Myers<sup>3</sup> commented on its relative scarcity in the Guianas.

*Hypsilonotus fulvus* Deg. This Coreid was frequently seen on cotton, but never in large numbers. The indications are that the BHC dusts and dieldrin sprays applied against *Dysdercus* are also effective against this species.

*Alabama argillacea* Hb. Although this species is so important elsewhere in the Americas, in British Guiana it appears to be insignificant. It was found on cotton whenever a search was made for it, both on the spring and autumn crops, but specimens were difficult to find.

*Aphis gossypii* Glov. Infestation by this aphid was generally most severe on poorly grown cotton. Heavy rainfall caused a great reduction in numbers. *Coleomegilla maculata*, *Cycloneda sanguinea* and a

third, smaller species of Coccinellid that was not identified were observed to be predacious on *A. gossypii*. The Coccinellids were destroyed by BHC dusts and dieldrin sprays applied against stainlers, and this resulted in an increase in aphid infestation.

*Tetranychus* spp. The Upland varieties, particularly the American Uplands, appeared to be the most susceptible to mite infestation, which occurred during the later growth in the dry season. Infestation results in leaf shedding, but the importance of this at the stage when it occurs is doubtful, as a certain amount of natural shedding always takes place at this time.

*Agrotis repleta* Wlk. and *Scapteriscus didactylus* Latr. appeared to take a certain toll of young seedlings, which normally could be overcome by sowing at a higher seed rate.

*Saissetia nigra* Nietn. and *Pinnaspis (Hemichionaspis) minor* Mask. These Coccids were found to occur mainly on the thick stems of perennial cottons and on the old base of the stem of annual cottons which had been ratooned. They also appeared to be more numerous on the young stems of ratooned cotton than on the stems of the sown crop, i.e. ratooning itself appeared to favour infestation, independently of stem thickness.

*Anthonomus grandis* Boh., *Heliothis zea* Boddie, *Platyedra gossypiella* Saund. and *Sacadesodes pyralis* Dyer were not found during the investigation.

#### ACKNOWLEDGMENT

I must thank Mr. E. O. Pearson, Director Designate, Commonwealth Institute of Entomology, for valuable advice on the taxonomy of the New World species of *Dysdercus*, and for bringing the literature to my attention.

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Received January 1958.

## "WHAT TYPE SHALL WE GROW?"

D. F. RUSTON

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WHEN new areas are being opened up for cotton production, one of the first problems to be considered is the type of cotton to be grown. The same problem can also apply in areas that have hitherto been content to grow "bread and butter" types, which have to compete against large established areas such as the United States, and with almost all newcomers into the field of cotton growing. For the purposes of this note, type will be considered as a measure of the staple length, other fibre characteristics being covered by varietal and grade differences within a type.

In general each territory will grow the type of cotton best suited to its conditions, but it is not always easy to determine what this is. Obviously the type to be aimed at should be that which will, over the years, bring in the greatest return per acre, this return being a combination of yield and price.

Yield estimates are comparatively straightforward, being obtained from the results of trials carried out over a number of years on experimental stations and in district plots. Estimates of the price to be obtained for the lint, however, are, and must remain, something of a gamble, although some help can be obtained by studying the relative prices of different types over a number of years.

An example of the way this can be done is given in Table 1. It should be emphasized that this table is not intended to be an actual comparison of the expected returns from growing the two types mentioned, but is merely an illustration of how any two differing types can be compared. Whilst the two types may differ in a number of respects—length of growing season, size of boll, ginning outturn, etc.—all these factors are for simplicity covered by yield of lint per acre.

Column 2 of Table 1 shows the average price of Egyptian Ashmouni G/FG at Liverpool for each of the last eight years as a percentage of the price of American Middling  $\frac{15}{16}$  inch. It is clear from this column that if

TABLE I

Year	Price of Ashmouni G/FG as % of A.M. $\frac{15}{16}$ inch	$\%$ Return from Ashmouni G/FG if yield as % of A.M. were		
		80%	85%	90%
1949 ..	.. ..	124	99	105
1950 ..	.. ..	146	116	124
1951 ..	.. ..	150	120	127
1952 ..	.. ..	112	89	95
1953 ..	.. ..	107	85	90
1954 ..	.. ..	121	96	102
1955 ..	.. ..	114	91	96
1956 ..	.. ..	156	124	132

the yield which could be obtained from Ashmouni was the same as that which could be obtained from American Middling, there would be no difficulty in deciding which type to grow.

In general, however, the yields per acre obtained from the longer and finer stapled types are lower than those of shorter and coarser stapled types, and in these cases some estimate of yield multiplied by price must be obtained. The last three columns of the table show the return which could be expected from growing Ashmouni cotton in comparison with American Middling if the yields from Ashmouni were 80, 85 or 90 per cent. respectively of those that could be obtained from growing American Middling.

It can be seen from this table that if the yield which could be obtained from Ashmouni were only 80 per cent. of the yield of American Middling, it would not have paid on average to grow the longer stapled type. With 85 per cent. yield it would have paid on balance, and if 90 per cent. yields could be obtained, the return from growing Ashmouni would over the eight years have been considerably better than from American Middling.

The prices given in Table 1 were the average prices for a whole year. Table 2 shows the price of American Middling at the end of each month for the last two years. The further columns give the relative prices at the same time of four other types of cotton of increasing staple length.

Whereas the prices of the shorter staple types showed a comparatively

TABLE 2

	Actual price pence per lb. American Middling $\frac{1}{8}$ inch	Relative prices at Liverpool % of A.M. $\frac{1}{8}$ inch			
		Nigerian N42 1 inch	East African Teso 2 $1\frac{1}{8}$ inch	Peruvian Tanguis G $1\frac{1}{8}$ inch	Sudan L3 $1\frac{1}{2}$ inch
1956 March	27.55	110	120	130	173
April	28.45	106	120	126	179
May	28.58	104	125	135	181
June	28.65	103	116	131	180
July	26.40	112	125	141	196
August	25.40	110	128	146	203
September	25.05	112	131	158	208
October	25.20	111	131	157	207
November	26.30	110	130	158	212
December	26.20	113	127	155	215
1957 January	25.70	116	127	158	222
February	25.15	117	130	158	227
March	25.00	119	122	154	229
April	25.30	113	122	150	N.Q.
May	25.45	116	121	151	N.Q.
June	25.55	114	119	153	197
July	25.35	117	120	159	196
August	25.35	117	119	154	187
September	25.45	112	119	149	180
October	25.10	114	121	149	183
November	25.60	111	118	146	161
December	25.45	114	119	147	162
1958 January	25.30	116	120	139	160
Range	..	103-119	116-131	126-159	160-229

small variation throughout the two years, the variation increased steadily as the staple lengthened. In the case of the longer staple types, such as Sudan, the variations were, of course, accentuated because of the Suez crisis, but it is clear that price variations are likely to be much greater with the longer staple types than with the shorter staples.

In recent years in trade papers and at meetings there has been mention of the need for a good type of long staple cotton of around  $1\frac{1}{4}$  inch in length, with a good strength and a clean fibre, which would be easy to card. These specifications are very similar to those of Egyptian Ashmouni as it was prior to 1951 when deterioration began to set in.

Is there any other evidence to back up the trade views regarding the need for such a type? It would seem that there is, as a study of the figures in the Quarterly Bulletin of the International Cotton Advisory Committee confirms that world production of long staple types has in fact failed to keep pace with the general increase in cotton production in recent years.

TABLE 3.—FREE WORLD PRODUCTION

	Average 1934-8	1951-2	1952-3	1953-4	1954-5	1955-6	1956-7
1,000 bales of 478 lb.					+		
All lengths	24,167	28,634	28,980	30,349	29,562	30,834	28,842
Long staple	3,341	2,333	2,488	2,639	2,635	2,776	2,480
Extra long staple	821	938	1,432	1,005	1,018	1,105	1,384
As percentage 1934-38 = 100							
All lengths	100	118	119	125	122	127	119
Long staple	100	69	74	78	78	83	74
Extra long staple	100	114	174	122	123	134	168

Whilst over the last six years production of cotton of all lengths has shown an increase of from 18 to 27 per cent. over the pre-war average, and extra long staple cotton (over  $1\frac{1}{2}$  inch) has shown an increase of between 14 and 74 per cent., production of long staple cotton ( $1\frac{1}{2}$  inch to  $1\frac{3}{4}$  inch) has shown a decrease of between 17 and 31 per cent.

It would seem, therefore, that those countries which could successfully grow cotton of a staple length of between  $1\frac{1}{2}$  inch and  $1\frac{3}{4}$  inch would be well advised to test varieties coming within this range, and perhaps to concentrate on this length group rather than on shorter or longer types.

*Received February 1958.*

## SPINNING TEST RESULTS

A brief summary is given below of the main results of tests carried out by the Shirley Institute on samples submitted by the Corporation.

### LARGE-SCALE TESTS

	<i>Effect- ive length</i>	<i>Pressley strength</i>	<i>Matur- ity ratio</i>	<i>St. fibre weight</i>	<i>Count x strength</i>	<i>Yarn appear- ance</i>
<b>SUDAN 1956-57</b>						
<i>Egyptian S types</i>						
DS Av. of 2 ..	48	49.0	0.975	149	100's 2177	3.5
BAR 14/25 Av. of 3 ..	50	47.8	0.941	148	2223	4.1
<i>Egyptian L types</i>						
X1730A Av. of 3 ..	46.6	47.2	0.953	164	1777	4.6
BAR XL1 Av. of 2 ..	48	48.1	0.96	164	1888	4.5
BAR XL3 Av. of 2 ..	47.5	50.0	0.962	163	1784	4

Routine testing: it can be seen that the introduction of blackarm resistance has not led to any falling off in quality.

### SMALL-SCALE TESTS

		<i>Stel- rometer</i>			<i>40's</i>	
<b>SUDAN 1956-57</b>						
<i>American types</i>						
BAR 7/8.1 ..	35	18.9	0.73	193	2141	4
BAR 7/8.2 ..	36	18.6	0.715	196	2102	6
BAR 11/7 ..	33	20.2	0.76	193	2080	4
BAR SP84 ..	35	20.9	0.68	213	2059	5
PSS ..	33	19.7	0.71	196	1996	6
<i>Egyptian S types</i>						
BAR 14/25 Av. of 3 ..	49.3	27.0	0.89	158	80's 2099	5
<i>Egyptian L types</i>						
X1730A Av. of 2 ..	47	24.6	0.917	170	1665	5
Range of 24 blackarm resistant types ..	48 to 46	26.0 23.6	0.94 0.835	166 185	1721 1451	5 7
<i>Pima</i>						
S1 ..	47	28.7	0.97	142	2252	3.5
32 ..	49	28.7	0.86	165	2077	4
<b>TANGANYIKA 1957</b>						
<i>Lake Province</i>						
Normal Uki51 Av. of 2 ..	38	19.3	0.822	206	40's 1933	see below
Dull Uki51 Av. of 2 ..	38	18.3	0.817	212	1890	

Comparison of normal commercial FAQ cotton and cotton which was dull and characterless, possibly through having been left too long on the plant or in the grower's store. In yarn appearance the normal samples were slightly more regular and less neppy.

					<i>40's</i>	
<i>Eastern Province</i>						
47/10 .. .. ..	41	19.0	0.725	185	2087	3
Range of 22 varieties .. } ..	43	21.0	0.895	164	2308	2
	to 40	18.6	0.745	210	1913	4

Testing varieties in comparison with 47/10.

					<i>80's</i>	
<b>WEST INDIES 1957</b>						
<i>Montserrat</i>						
VH10 Av. of 2 .. ..	54.5	26.3	0.840	157	2298	4.75
Range of 10 MSI strains .. } ..	55	26.5	0.875	153	2374	2.5
	to 53	25.1	0.785	165	2120	5

Comparison of different strains of MSI with VH10.

## BUSMAN'S HOLIDAY

J. H. SAUNDERS AND A. LOW

*Empire Cotton Growing Corporation, Sudan Republic*

OUR decision to spend our next leave together in East Africa arose when we were touring the Nuba mountains in December 1956, examining native cotton cultivation and checking on variety trials. This was Alistair Low's territory, and Jack Saunders was the visitor. The bone-shaking quality of the local roads led Alistair to sigh for the excellent highways of East Africa, his home country. We soon decided that it would be perfectly feasible to take our private cars, a Consul and Zephyr, to East Africa by way of the Nile. We could then take the opportunity to visit our colleagues within the Corporation, making it a "busman's holiday" with the emphasis on the holiday. Permission was duly given by the Corporation with the proviso that we should spend some time at a suitable altitude to enable us to return to our work in the Sudan as though we were in fact returning from a holiday and not in need of one. No orders could have suited us better, since the White Highlands of Kenya, where we intended to stay for one month, are very lovely.

Our holiday really began on board the *Nasir*, the flagship of the Nile fleet of steamers, on May 1, 1957, when we sailed for Juba. However, the gruelling drive from Wad Medani to Costi should not pass without mention. It is 120 miles of the most formidable corrugations we have ever seen, set in terrain of utter desolation with the odd carcass decorating the route as a gentle reminder not to tarry on the way. The dam across the Nile at Sennar at the mid-point of this journey is worthy of a pilgrimage. The reserves of water built up behind this dam feed the great Gezira scheme and so provide the Sudan with the greater part of her wealth.

Once aboard the paddle steamer we looked forward to ten days of enforced idleness. These Nile steamers are affairs not of beauty but of utility, being shallow draft, two-storied boxes of rectangular shape pushed from astern by a giant paddle wheel. Any resemblance they may have on first sight to a Mississippi Show-Boat is purely coincidental. Rather in the manner of fussy ducks, they gather about themselves barges of like construction which are lashed alongside and ahead. Thus equipped they ply their trade up and down the Nile from Costi to Juba at a steady 6 or 7 knots; where the river meanders and narrows, as it does in the Sudd, progress becomes that of a drunkard's lurch from corner to corner.

The cars were secured on the lower deck of the barge forward and we were uneasy to see that an unclassifiable community lived around them with their livestock over and under them. Cooking was carried on over little fires built in tins on the iron deck, far too close to our property for our liking.

Our companions for the journey were two families of American missionaries returning to their stations, an Italian Catholic priest and an Italian nun, the latter two also returning to their missions from which

they had been absent for the first time in ten years and then only as a result of illness. All these people wished for was to continue their work in this very hard country.

The trip was definitely hot and we sweltered most of the day, but we were fortunate in that the skipper of the *Nasir* was extremely friendly and was anxious that we should enjoy our time on his ship; the service and food were excellent. The evenings were a welcome relief; deckchairs, shandies and the Southern Cross made up for the heat of the day. We did not see very much game; no crocodiles, some hippo and few elephant apart from one very big herd which could have been a thousand head. The Sudd becomes very monotonous, since day after day nothing is seen other than endless papyrus.

We were booked to stay the night at Paraan, in the Murchison Falls Game Park, in Uganda, on the day of our arrival in Juba. Since it was a journey of some 300 miles an early start was essential, but we did not get on the road until 11 a.m. after off-loading our cars and passing through Customs and Immigration. From this time on, roads ceased to be our major headache; the road from Juba to Nimule, the Sudanese frontier post between the Sudan and Uganda, is metalled and in good condition. Ninety miles from Juba we stopped to aid another traveller in obvious difficulties. Low, being the expert, was soon in the bowels of the stranger's car; Saunders out of idle curiosity peered under his own car bonnet. A wave of heat and a gurgling sound from the radiator greeted him. Closer inspection showed that the fan belt was missing and that the generator was hanging by one bolt. Since we had not stopped on our own account there is a moral here somewhere!

The steady climb to the heights above Nimule was a strangely pleasing experience, since we had been living on the billiard-table top of the northern Sudan for the last year. We stopped at the highest point and looked back and down towards the Sudan and the Nile, which seemed so far below; everyone thought it rather wonderful.

The Uganda frontier post is some 15 miles inside the border, at Atiak. An Indian Customs officer, presiding over the neatly whitewashed Customs post, greeted us cordially and proceeded to make good certain deficiencies in our arrangements to stay for two months in East Africa. He raised an eyebrow when we said that we intended to spend that night at Paraan. He told us that the Game Park closed its gates at sunset and that since it was ninety miles away we could not hope to get there in time. This puzzled us until he asked us if we had adjusted our watches to Uganda time! We had not, of course, and found ourselves robbed of one hour. There was nothing for it but to make for Gulu, 45 miles away, and hope that the rest house would be able to provide beds and meals for our unwieldy party. This they did and we were very grateful.

Paraan gave us full measure of elephant, crocodiles, hippo, buffalo and even a distant rhino. We hired a launch which took us to the Falls and back, and the resident clown elephant, called the Lord Mayor, obligingly did his rounds of the chalets and chased the parrots out of their tree whilst we were there. We read later that he had become too familiar and had pursued the Game Warden and his companion; one escaped by diving

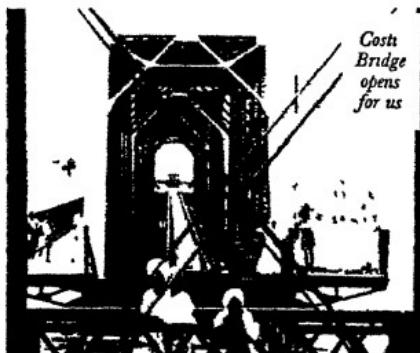
PLATE



*Ready to go*



*A Nile Paddle Steamer*



*Costi  
Bridge  
opens  
for us*



*On the bridge of the "Nasir"*

PI VII III



PLATE IV



Kenya - Crossing the  
"line" at 9,000 feet

Vera Lou, Dorothy Saunders and Bryan Lou



PLATE V



into the Nile, the other took refuge on a launch. After this the " Mayor " was deposed.

And so to Namulonge via Masindi. The roads on the way were to our Sudani eyes marvels of motoring luxury. Towards Kampala giant earth-moving machines were taking huge bites out of hillsides and disgorging these mammoth mouthfuls into the next valley. In this way comparatively level roads were being driven through undulating country. The extent to which this had already been carried out is an engineering triumph. In order to approach Namulonge itself we were obliged to leave these wonderful tarmacadamed highways and proceed along the more familiar mud track. This seems to be a necessary adjunct to any agricultural research station and we were not disappointed. We entered Namulonge and caught our breath when we saw the beautiful rolling green grassy slopes and the picturesque English type houses scattered amongst them. It was worth the drive from Wad Medani to Kosti.

Our four days at Namulonge were intensive. We endeavoured to plague as many people as possible in that time to instruct us into all that went on there with regard to cotton. Everyone was most obliging and nothing seemed to be too much trouble. From the " country cousins " point of view the outstanding advantage of Namulonge is the fact that the staff is a team of specialists all working exclusively on cotton problems. So often, apart from the cotton breeder, specialists in other fields at the same station are responsible for *all* other crops and so can spare little time for full investigations on cotton problems. Sir Joseph Hutchinson kindly showed us around the farm, explained its history and development, and then handed us over to the members of the staff, who in turn gave us their time, and too much to think about to record in this short note.

Namulonge dined and wined us to bursting point. Kenya meat is a joy and we did full justice to our meals. Nevertheless we had to be on our way, since we had a date with the lake steamer at Kisumu which was going to take us to Mwanza in Tanganyika. We were met at Busia on the Uganda/Kenya border by Malcolm Hastie, the Corporation's cotton breeder at Kibos, who escorted us to Kisumu, where he and his wife, Christine, entertained us until it was time for us to board the steamer. We left our cars at Kisumu for a much needed oiling and greasing, and had an enjoyable two days on this very comfortable ship.

At Ukariguru Mr. Peat, now the Corporation's senior officer in East Africa, is head of the government research station. Though unfortunately on leave at that time, he had kindly left his house at our disposal. The arid quality of the countryside in Tanganyika was in sharp contrast to the lushness of Uganda and Kenya as we had just left them, but it was not as harsh as the Sudan. We spent busy days with our hosts seeing their experiments and talking over their programmes. Both blackarm resistance and jassid resistance figure largely in importance. In East Africa the problem of breeding for blackarm resistance is more complicated than in the Sudan. Genes which give a measure of resistance in the Gezira are useless here. Jassid resistance appeared to be straightforward. Selection for hairiness had already shown considerable increase in resistance, and as could be judged from varieties examined, considerable variability in this

character remained to be exploited. Outside the farm we saw a representative part of Sukumaland and stopped at the scattered native cotton cultivations. These small holdings told the same story as all other African territories where cotton is the cash crop of the native cultivator. His cotton is the same variety that is grown so well and with such good yields on the experimental farm, but it is hard to recognize it as such in the field. The reason is not hard to find. It is not planted early enough and often not weeded enough in its early life. This is simply because the food crop goes in first, and since this is the true wealth of the peasant it receives pride of place. Money is not so important yet that the African will rely on it to feed himself and his family. However, many patches contain cotton grown well enough, if not as well as it could be grown. Thus it is that most breeders concerned with the cotton growing countries of Africa, with the single exception of the long-staple areas of the Sudan, realize that the biggest increases in overall output that their countries can achieve is by improved native agronomy.

Tie-ridging has been found to be beneficial in Tanganyika. The ridges there were the most enormous that we have ever seen, each ridge being some 5 feet from the next and big in proportion. Leaving cotton for a while, we were given an outline of the work in progress on sorghum; the problem of bird resistance is being tackled by breeding (a) an unpalatable type and (b) a type with a very open panicle and/or a drooping or hanging head upon which the birds would have difficulty in roosting and pecking. We were looked after magnificently by our hosts at Ukiriguru, though as a postscript we would warn others who may follow our footsteps that the water there is neat Epsom salts, so do not pack your own.

From Ukiriguru we returned to Kisumu, which impressed us as a very pleasant, clean little town. It and Kampala had impressed our wives even more, and to see so many shops was becoming a strain, but by mumbling "Nairobi" and dangling this as a sort of carrot in front of their noses we staved off the worst.

On the attractive research farm at Kibos a small ginnery was nearing completion at the time of our visit, where it is intended to teach African gin operators the correct way to handle the cotton crop. This education should result in less loss in quality from bad handling and the crop will be of greater monetary value to the Colony.

Our visits to research stations were now temporarily over and we set off for Nairobi. The 20 miles of dirt road to the escarpment at the foot of the Highlands was a sea of mud, but fortunately the roads were well made and this mud did not go deep. Nevertheless it was like driving on butter and we dared not stop before reaching the higher, well-drained land. We stopped at a farm at Lumbwa owned by some friends of Alistair's, where we had an excellent lunch. This was a poultry farm, and an ingenious use had been made of the droppings accumulated in the deep litters. They had built a gas generator which was simply a place where the droppings were allowed to ferment, and the marsh gas released was collected under a home-made gasometer. This gas provided lighting, cooking and refrigeration.

Then Nairobi, which we found most impressive with its modern

buildings and attractively designed shops. Much use was being made on buildings just reaching completion of bright pastel coloured stucco fronts. The Nairobi traffic was reminiscent of London in Coronation year. Cars were nose to tail and every parking space was occupied.

The Nairobi Game Park gave us full value. We were waiting outside the gates in the early half-light for it to open, and within a half an hour of being inside we had found a pride of eight young lion obviously well fed from a kill of the night before and quite indifferent to our approach. We were able to get within 5 feet of the nearest and obtained colour pictures of them which we were informed by Kodaks in Nairobi were amongst the best that had been seen. The black-and-white illustration included amongst the plates with this article is by way of proof how close we were. The white triangle in the lower left-hand corner is the front wing of the Zephyr from which this picture was taken. Any lack of focus can be attributed to camera shake! At one time one lion decided to lean against the boot whilst two others were across the front of the car. No hostile move was made, but when one young male decided to investigate the palatability of Michelin tyres we decided that it was time for us to move. It was the experience and thrill of a lifetime. Of course the ostrich, wildebeest, zebra, giraffe and buck were no less interesting, but somehow the big cats must always steal the show.

A week of Nairobi and the coffers were sounding a bit hollow, and so we moved off for the next stage of our tour. The Lows were to go to Alistair's parents at Endebess on the slopes of Mount Elgon and the Saunders to a delightful hotel called Crampton's Inn 4 miles out of Kitale and 20 miles from Endebess. It was in this beautiful highland area that we all planned to have that rest which should set us up for our return to the Sudan. The foothills of Mount Elgon are some 6,000 to 7,000 feet, whilst Elgon itself rises to 12,000 feet. The grass was rich green all around, the afternoons brought gentle rain, the days were warm and sunny and the nights crisp, so that one could enjoy sitting by a log fire. A riot of English flowers grew in the gardens; enough to break the heart of an Englishman living in the Sudan, where the elements begrudge you every blossom not native to its soil.

It was with reluctance that we said farewell to the Kitale district and started on our return to Juba. The research station at Serere was on our list and so we spent two full and interesting days there. This station is in the process of rapid expansion and has just acquired some magnificent new laboratory buildings. The Corporation's cotton breeder, Peter Walton, was on leave, but the botanist showed us a great deal of very interesting material that would have kept many breeders busy.

And now it was time to pick up the threads of our own research problems back in the Sudan, and we felt fortified by having had such a free exchange of views with others who were also concerned with crop improvement. As we entered Juba on the last leg of our motoring tour the air was slowly but surely leaving one of the tyres of the Consul; this was the one and only puncture during the 3,000 miles we had covered. In some ways, too, we were all feeling a little deflated, since it was not easy to leave lovely East Africa.

## BOOK REVIEW

COTTON. H. B. Brown and J. O. Ware. McGraw-Hill Book Co., 95 Farringdon Street, London, E.C.4. Pp. 566. 93s.

This is the third edition of the book "Cotton" by H. B. Brown which was originally published in 1927. It is now twenty years since the second edition appeared in 1938 and for the cotton growing industry in the U.S.A. these twenty years have been particularly momentous, average lint yields per acre during that time having increased from 235 lb. to over 400 lb. The reasons for the increase are numerous—a switch to new areas, increased irrigation, increased use of fertilizers, insecticides and weedicides, the use of improved varieties and a host of other minor reasons.

As a result of all these changes, combined with the greatly increased use of mechanization for growing and harvesting the crop, the book has been largely rewritten and brought up to date by the junior author, using as the basis the well-established groundwork of the earlier editions.

"Cotton" continues to be an invaluable reference book, dealing as it does with the history of cotton; the taxonomy, morphology and physiology of the cotton plant; problems and methods of cotton breeding and a brief description of the cultivated varieties; together with chapters on such subjects as climate and soils; soil fertility; diseases and pests; the cultivation, harvesting and ginning of cotton; a description of the new apparatus used for measuring fibre characters; and sections on classification, marketing and manufacture. It is, therefore, all-embracing and its usefulness is enhanced by a long list of references at the end of each chapter.

As would be expected, the book deals largely with cotton growing in the U.S.A., but since the crop from this country accounts for roughly 35 per cent. of the total cotton grown in the world it is, for the general reader, none the worse for that, particularly as the basic principles of cotton growing and processing are much the same in all parts of the world.

Readers who are especially interested in details of cotton growing in other areas, e.g. Africa, however, will for these reasons and because of lack of space find that the information given in the text is not quite as full as that for the American crop. Nor is it as up-to-date for these areas as the publication date of 1958 might imply, the latest production figures for most of the African territories, for example, being those for the year 1952.

Such criticisms, however, are very minor in comparison with the undoubted value of the book to all engaged in research and experimentation in cotton growing wherever they may be stationed, and the authors are to be congratulated on covering such a large and complex subject so thoroughly.

From the Corporation's point of view it is extremely gratifying to find that the classification given in "The Evolution of *Gossypium*"—the final report of the Genetics Department of the Empire Cotton Growing Corporation's Research Station in Trinidad—and in later articles by the staff, has been accepted as the standard classification, and that extracts and illustrations from this book form a very large part of the chapter dealing with taxonomy.

"Cotton" is well produced in clear type and contains a large number of up-to-date illustrations.

D.F.R.

TERRITORIES IN WHICH CORPORATION STAFF ARE WORKING  
Bales of 400 lb.

Territory		Harvest completed	1957		1958	
Uganda ..	.	March	372,400		320,000	
Kenya ..	..	March	7,900		12,600	
Tanganyika:						
<i>Lake Province</i> ..	..	August	153,500		120,000	
<i>Other Provinces</i> ..	..	November	16,400		18,000	
Nyasaland ..	..	August	7,000		—	
Nigeria ..	..	February	143,500		225,000	
Sudan Republic:						
<i>Egyptian "S" and "L"</i> ..	..	May	661,500		200,000	
<i>American Upland</i> ..	..	February	43,100		75,000	
Aden ..	..	May	28,300		29,500	
West Indies ..	..	April	3,700		5,700	
Total ..	..	..	1,437,300		—	

WORLD PRODUCTION\*

(Bales of 478 lb.)

	Season 1957-58	% of total
United States ..	10,900,000	27.9
Mexico ..	2,050,000	5.2
Argentine ..	550,000	1.4
Brazil ..	1,250,000	3.2
Peru ..	450,000	1.2
Egypt ..	1,804,000	4.6
Other Africa ..	1,841,000	4.7
India ..	4,225,000	10.8
Pakistan ..	1,435,000	3.7
Syria ..	450,000	1.2
Turkey ..	500,000	1.3
Europe ..	647,000	1.7
U.S.S.R. ..	5,700,000	14.6
China ..	6,000,000	15.4
Others ..	1,208,000	3.1
World Total ..	39,010,000	100.0

\* From International Cotton Advisory Committee.

## ABSTRACTS

### COTTON IN AFRICA

#### **Egypt**

**62.** The third official estimate of the current crop compared with last season's final outturn as follows:

				<i>1956-57</i>	<i>1957-58</i>
				<i>Cantars</i>	<i>Cantars</i>
Karnak ..	..	..	..	2,132,282	2,016,141
Menoufi, Giza 45 ..	..	..	..	829,181	1,882,328
Giza 30 and 47, Dendera ..	..	..	..	1,317,940	1,093,980
Ashmouni, etc. ..	..	..	..	2,781,510	3,639,045
				7,060,913	8,631,494
					or about
					1,800,000 bales (478 lb.)
				169,366	175,967
Scarto ..	..	..	..		

#### **Sudan Republic**

**63. 1956-57 Season.** The official estimate of the cotton crop was finally quoted as 704,645 bales (400 lb.), of which 661,544 bales were Sakel and Sakel type, 6,905 bales irrigated American type and 36,196 bales raingrown American. The total crop established a new high record, exceeding that of the previous year by 33 per cent. The main increases came from the gravity irrigated estates of the Gezira Board and the Private Schemes, while the Tokar Delta, where the failure of the flood resulted in no crop being sown in the 1955-56 season, produced 16,200 bales. The total area sown to Sakel types increased by 176,000 feddans, the greater part of which was in the Tokar Delta. There were small increases in the pump and flood grown American types from a somewhat larger area than in 1955-56, but the raingrown types showed a reduction of 37 per cent. compared with the previous year, from an area approximately 10 per cent. smaller.

**1957-58 Season.** It now seems certain that this year's crop will be the smallest for several years, as reports from the Gezira area, which last year accounted for about three-quarters of the total crop, indicate a reduction of yield from more than  $6\frac{1}{2}$  cantars to less than 2 cantars per feddan. The Nuba mountains crop of American raingrown cotton may, however, establish a record for quantity, and the Equatoria crop also has developed well.

A newsletter from the Uganda Cotton Association reports that the Sudan cotton area will be increased by a further 200,000 feddans next August when the first section of the Managil development scheme should be ready for planting. The completion of the project in four years' time will bring the irrigated area of the Gezira to 1,750,000 feddans.

Other items in the working programme of the Gezira Board include the modernization of its eight ginning factories, improved agronomy and pest control, the utilization of by-products from the cotton plant, and the extension of the Board's light railway network to the Managil area, which will lengthen the network from 300 kilometres to about 730 kilometres.

**Sudan**

**64. Progress Reports from Experiment Stations, Sudan, Season 1956-57.** (Emp. Cott. Gr. Corp., 1957). *The Gezira Station.* M. F. Rose, L. C. Hughes and A. Low. In accordance with the record territorial crop of over 700,000 bales (400 lb.) record yields were also obtained from the Gezira Station, where 63 acres under Sakel averaged 2,047 lb. seed cotton per acre and 121 acres of X1730A averaged 2,434 lb.

The blackarm situation in the Gezira and at Shambat showed a very definite change in 1956-57. Planting conditions were good during mid-August, but after heavy rains and flooding early in September a systemic type of infection occurred which developed early in the season and produced leaf and stem lesions later. All  $B_2B_1$  types, previously considered near immune, showed full grade 7 to 8 susceptibility, but  $B_2B_3B_6$  stocks showed full immunity. Later in the season the crop showed a remarkable recovery, which together with the absence of premature senescence, the retention of the bottom crop and the very high boll weights, contributed towards the record crop.

In the breeding programme the importance of  $B_6$  was emphasized throughout the season, and the first Sakel type bearing  $B_2B_3B_6$  genes was passed to Medani for testing as BAR 14/48. The corresponding L type cottons—BAR 4/25 and BAR 5/7—were also under test. Yield figures were encouraging, and practically all these types showed complete immunity to systemic attack.

It is evident, however, from the work on jassid resistance accomplished so far, that the gene  $H_1$  has reduced both yield and grade, and the gene  $H_3$  will therefore be used as far as possible in future.

It is expected that the cotton acreage will expand considerably as a result of the vast development schemes at present under construction, and that an alternative type of cotton may then be required. To serve this possible need Tanguis has been crossed to BAR 14/25 in order to combine the whiteness, high ginning outturn and high boll weight of Tanguis with the earliness and blackarm resistance of BAR 14/25.

The standard variety trials were continued at Turabi in the north, the Gezira station and Hag Abdulla in the south. In general, the new derivatives were satisfactory in comparison with the standard S and L types. For the past two years, the S types have yielded particularly well in the south, where they normally yield poorly, and the possibility of a change in the climatic régime has been put forward. The effect of environment, spraying and manuring on grade is also being considered.

In order to improve the strength of the American raingrown types, Hopi Acala was crossed with BAR 7/8.2 and BAR 11.7.

*Shambat Station.* S. O. S. Dark and J. H. Saunders. At the Shambat station also the work on blackarm resistance was of major importance; and resistance genes were transferred to Karnak, Pima S<sub>1</sub>, Acala 4-4-2, PSS, SP84, Wilds SUS and BP52.

This year's work on jassid resistance has been confined to obtaining lines homozygous for  $B_2B_3$ . This has been a necessary phase in the work, since jassid resistance without blackarm resistance would be unacceptable for the Gezira.

As the blackarm resistant Sakel type BAR 14/25 has no leafcurl resistance, this character is being introduced by crosses with L cotton and with BLR 14/16.

*Kadugli Station.* M. F. Rose, A. Low and Hamdan Eff. Hannay. In the raingrown areas BAR 7/8.2 again yielded well, giving a 9 per cent. lint increase over BAR 7/8.1 and a 35 per cent. increase over BAR 11/7. BAR 11/7, however, is of higher quality and efforts are being made to improve both the quality of BAR 7/8 and the yield of BAR 11/7. Further work was continued within BAR 7/8.3, which was selected for reduced seed coat nep.

In agronomy trials cotton on the flat again outyielded ridged and tie-ridged cotton. Ridging is a safeguard against sheet erosion, but otherwise it appears to reduce and not to increase yield.

**65. Agricultural Research and Development in the South-west Sudan. Part II.** S. G. Willmott and K. R. M. Anthony. (*Tropical Agriculture*, 35, 1, 1958, p. 16.). The second part of this paper is concerned with the problem of soil fertility. A land use survey of Equatoria revealed that less than 2 per cent. of the land was cultivated annually, although 87 per cent. is potentially workable. Despite this abundance of land and the natural cover of trees and grass that protect it, the native agricultural practices of shifting cultivation and annual burning continue to cause an overall decline in soil fertility and the destruction of climax vegetation over large areas, with resulting loss of rainfall from evaporation and surface runoff.

While the economics of artificial fertilizer application preclude their use at present, it is considered essential that the research worker in this area should first determine the needs of the soil and whether there is any significant reward in crop yield from their use. The introduction of such crops as sugar, tea, coffee, palm oil, tobacco and tropical fruits is recommended, and it is pointed out that land utilization by the growth of perennial crops incorporated in existing agricultural systems in the south would reduce the level of imports into the country as a whole. The Sudan could become virtually self-sufficient in staple foods and commodities if the internal agricultural economy were changed.

#### French Equatorial Africa

**66. Windel's Review.** Cotton production in French Equatorial Africa during the season August 1956-July 1957 was estimated at 155,000 bales (500 lb. gross), down slightly from the 1955-56 crop of 165,000 bales, but about the same as in 1954-55. The reduction in 1956-57 was attributed to unfavourable weather in several regions, and a slight reduction in the area harvested—785,000 acres, compared with 800,000 in 1955-56.

Planting of the 1957-58 crops was completed in September 1957. Prospects this year are for a further slight decline in area to about 775,000 acres. Production is estimated at 160,000 bales, assuming normal weather conditions.

In recent years the Cotton Research Institute has made wider distribution of improved seed for planting. This has tended to increase yields per acre and also the ratio of lint to seed. The average yield, however, is still slightly less than 100 lb. of lint per acre.

Most of the cotton is grown in the northern part of the country, where there is less rainfall and a more pronounced dry season. About 65 per cent. of the crop is grown in Tchad Province, the remainder in Oubangui-Chari. About two-thirds of the crop in 1955-56 was of the Allen variety, the remainder mostly Triumph. A new variety, Banda, was introduced in 1956-57 and is expected eventually to replace Triumph.

There are four companies that operate ginneries and buy seed cotton from the producers. Virtually all cotton is grown by small producers planting less than 1 hectare—2·471 acres. These firms also handle all cotton exports. All French Equatorial cotton is exported, principally to France. There are no cotton mills in operation, and other consumption is negligible.

Cotton stocks on August 1, 1957, were estimated at 46,000 bales, compared with 97,000 bales held a year earlier. The carryover usually is from one-third to one-half of the crop during the year. Long distances between producing zones and ports may cause considerable delay between harvest and export. The size of the carryover varies according to conditions of roads and waterways, and available cargo space for export shipments. In recent years there has been no appreciable carryover of old crop cotton.

Government measures to encourage the growing of cotton include a sowing premium, generally distributed to producers at the time the crop is planted. In 1956-57 this premium amounted to about \$2.00 per acre. There is also a Cotton Price Stabilization Programme, partly financed by an export tax of 12 per cent. In 1956-57, producers were guaranteed a price equivalent to 6.2 U.S. cents per pound for first quality seed cotton, and 5.2 cents per pound for second quality. Transportation subsidies are also in effect.

### **British West Africa**

**67. Nigeria. 1957-58 Season.** According to Windel's Cotton and Economic Review, the arrivals of seed cotton at most marketing centres in the Northern Region have been much heavier than they were last year, and estimates of the total lint outturn have been increased to around 220,000 bales (400 lb.). As a result of the ideal growing season, the quality of receipts is well above average both as regards grade and staple character, the percentage of Grades 2 and 3 being remarkably small.

The Nigeria Trade Journal quotes the final producer prices for seed cotton paid by the Northern Regional Marketing Board as follows:

<i>Pence per lb.</i>			
<i>Kuru, Zaria, Funtua, Malum Fashi, Gusau and Lokoja Ginnery Zones</i>		<i>Mai Inchi and Kontagora Ginnery Zones</i>	<i>Gombe, Kumo and Misau Ginnery Zones</i>
Grade NA1 ..	6·1	6·0	5·9
Grade NA2 ..	5·6	5·5	5·4
Grade NA3 ..	5·1	5·0	4·9

The "zonal" producer-price structure which has now been introduced takes some account of unequal transport costs from ginnery to port and represents a first step towards the fixing of true economic prices.

The Regional Department of Agriculture has opened a new ginnery at Chafe, one of the main cotton buying stations in Sokoto Province. The British Cotton Growing Association is building a £30,000 ginnery at Kumo in Gombe Emirate.

A notice issued by P. Dolan and Associates quotes the prices fixed by the Western Regional Marketing Board for this year's seed cotton crop as Grade 1, 5·75d. per lb.; Grade 2, 5·50d.; and Grade 3, 5·00d. These are the same as the prices paid for the previous crop.

### **Belgian Congo**

Windel's Review reports that unfavourable climatic conditions during harvesting again badly affected both yield and quality in the Northern Areas, and it is unlikely that the cotton crop will exceed last year's low production of 22,000 tons of lint.

In the Southern Areas a new variety called "C2" has been introduced recently. Tests carried out through several years have shown that this cotton is superior in yield and in quality to the GAR hitherto cultivated. It is estimated that the next crop beginning in July will produce 2,000 to 3,000 tons of "C2" fibre.

During 1957 about 38,000 tons of Congo cotton were exported to Antwerp of which about 17,700 tons were sold to Belgian mills and the remainder transhipped to other countries.

### **British East Africa**

**69. Uganda. 1956-57 Season.** The total production of cotton lint was estimated by the Department of Agriculture at 372,433 bales (400 lb.). The prices paid to producers for seed cotton were 55 E. African cents per lb. for S47 and 56 cents for BP52. The cash receipts by growers for the sale of the crop was estimated at £13,081,117.

**1957-58 Season.** According to Windel's Review and current bank reports the revised total acreage figures of 1,617,013 acres show an increase of approximately 48,000 acres over the 1,568,538 acres planted last year, the increase being made up of 26,000 acres in the BP52 areas and 22,000 acres in the S47 areas.

Despite timely planting over much of the Protectorate, however, the crop is expected to be considerably below that of 1956-57, largely because of the hot, dry weather during the beginning of the season. The situation was improved somewhat by heavy rain during November and December, though this gave rise to raintainting of early harvested cotton. Grade improved as the season progressed, and the estimate was raised to 320,000 bales.

To compensate growers for the reduced yields, producer prices for seed cotton have been raised by 2 cents per lb. over those of the previous years as follows:

	<i>Cents per lb.</i>
Clean S47 .. .. .. ..	57
Clean BP52 .. .. .. ..	58
Stained West Nile Zone .. .. .. ..	25
Stained other districts .. .. .. ..	22

These prices are above present ruling world levels, and may entail a subsidy of about 5 cents per lb. (totalling approximately £1,250,000) from the Cotton Price Assistance Fund.

The following figures quoted from recent newsletters issued by the

Uganda Cotton Association indicate the development of the cotton crop through the past forty years:

<i>5-year average</i>	<i>Acres</i>	<i>Bales 400 lb.</i>	<i>Approx. average price for seed cotton paid to grower. Cents per lb.</i>
1914-18	117,000	28,600	
1919-23	217,400	58,000	
1924-28	535,800	154,600	
1929-33	808,000	204,000	
1934-38	1,369,000	321,000	10.50
1939-43	1,254,000	264,500	9.40
1944-48	1,148,400	217,950	16.60
1949-53	1,551,000	355,550	40.00
1954-58	1,624,000		

A survey of ginneries reported by the Standard Bank of South Africa showed that although there were 145 ginneries in operation in 1957 as compared with 144 in 1956, the number of Africans employed in ginneries in 1957 decreased by 2,222 as compared with the number employed in 1956. Most of the ginneries employed between 100 and 200 men, but the number with over 200 employees fell from 32 in 1956 to 20 in 1957. According to the annual report of the Cooperative Development Department, ten ginneries were controlled by Cooperatives by the end of 1956 with another in the Mbale cotton zone under construction. The most important individual development is the purchase by the District Councils of West Nile and Madi of the West Nile Ginnery. This ginnery, which has one of the largest outturns in Uganda, is leased to a new cooperative known as the West Nile Cooperative Union. It is understood that after this season the Union will operate the ginnery themselves under the supervision of the Cooperative Department.

### Kenya

**70. 1956-57 Season.** The final figures for the cotton crop, issued by the Department of Agriculture, were as follows:

	<i>Acres</i>	<i>Bales of lint (400 lb.)</i>		
		<i>AR</i>	<i>BR</i>	<i>Total</i>
Nyanza Province..	.. 54,000	6,717	520	7,237
Coast Province ..	.. 19,900	360	362	722
	<hr/>	<hr/>	<hr/>	<hr/>
	73,900	7,077	882	7,959

The prices paid to growers for seed cotton were as follows:

	<i>Cents per lb.</i>			
	<i>Coast</i>	<i>Nyanza</i>	<i>Coast</i>	<i>Nyanza</i>
AR .. .. ..	54	55		
BR .. .. ..	20	20		

**1957-58 Season.** The crop has again proved disappointing in Nyanza due to the lack of rain; the estimate has been reduced to 10,000 bales,

while that of the Coast crop stands at only 2,600 bales. Producer prices for the current crop of seed cotton will be:

	Cents per lb.			
	Coast		Nyanza	
AR	..	..	60	57
BR	..	..	20	22

**71. Tanganyika.** *1956-57 Season.* The official estimate for the 1957 Lake Province crop was 153,500 bales (400 lb.). The Eastern Province produced a total of 12,000 bales—an increase of 3,000 over the previous season. In the Tanga Province the crop is better than was expected, but in the Northern Province the estimate has been reduced on account of rain damage.

The price paid to growers for Grade A seed cotton was 52 cents per lb. exclusive of the compulsory cess of 2 cents per lb. deducted on behalf of the native authorities.

*1957-58 Season.* Throughout the Lake Province, planting generally was later than last season and was followed by hot dry weather. A very preliminary estimate of the crop was 120,000 bales. With an increase in the acreage planted in the Eastern Province, crop prospects in March were reported to be good.

Negotiations are proceeding to make arrangements to market the production of the Northern, Eastern, Southern and Tanga Provinces ex coastal warehouse next year, instead of f.o.r. the ginner's nearest railhead, which is the present system. Owing to the inaccessibility of some of these places and the small quantities involved, in the past shippers have not normally sent representatives to sample and weigh over. This has led to many disputes and considerable uncertainty amongst shippers as to what they were likely to receive against their purchases. It is felt that bringing the whole crop to the coast, where it can be accurately sampled, weighed and classified, should solve many of these problems to the shippers' advantage.

It has now been decided to proceed this year with the multiplication of the new seed Ilonga 58 for eventual use in the Eastern Province. Spinning tests have shown that the lint from this seed is slightly better than the present 47/10, but the main improvement is the increase in the yield.

#### Central African Federation

**72. Nyasaland.** *1956-57 Season.* The Department of Agriculture reported that the cotton crop covered 27,089 acres, from which 7,000 bales (400 lb.) were harvested. In order to encourage production, which had fallen off as a result of two poor seasons in succession, the price for clean seed cotton was increased from 5d. to 6d. per lb., the price of stained cotton remaining at 2d. per lb.

*1957-58 Season.* An increased amount of cottonseed was issued for planting in the Lower River area, and germination and early growth are reported to be satisfactory.

Large-scale trials to test the effect of the eradication of *Sterculia africana*—the principal host of cotton stainer bugs—on the incidence of these pests were begun in October. The area involved is within a 5-mile radius of Sorgin in Port Herald district.

**73. Progress Reports from Experiment Stations, Nyasaland, Season 1956-57.** J. M. Munro. Emp. Cott. Gr. Corp., 1958. The Lower River crop showed a considerable improvement over 1955/56 as relatively dry weather in February and March stopped the spread of blackarm; the proportion of stainer-damaged cotton was much reduced, though 25 per cent. of the crop was still Grade 2.

In the Central Areas interest in cotton growing was lacking as a result of past poor yields. Following severe red bollworm attack and considerable stainer damage, the crop of the lake shore districts was less than half the 1955-56 total.

The report gives details of plant breeding work and variety trials with CL and Albar types, which are summarized in Abstract 74. More evidence is also presented of the appreciable drop in ginning percentage in the Lower River from 1952, when the planting season was advanced.

The Cotton Pest Research Scheme has started at Gatooma, Southern Rhodesia and Makanga, Nyasaland, on the lines proposed by Mr. E. O. Pearson in 1956 and with financial backing from the Federal and Nyasaland Governments and Colonial Development and Welfare Funds.

The report includes notes on the major cotton insect pests in Nyasaland by the Scheme's entomologist at Makanga, Mr. R. C. H. Sweeney, who works mainly on cotton stainlers.

**74. A637—A New Cotton Variety for Nyasaland.** J. M. Munro. (*Nyasaland Farmer and Forester*, 4, 1, 1957, p. 13.) A new variety—A637—is to replace CLB (Crown Land Bulk) as the commercial cotton of Nyasaland. CLB has been grown since 1933. It is a mixture of the older Nyasaland Upland variety and better yielding strains selected from the South African cotton U4, and for many years has given better yields than any variety tested against it in Nyasaland.

A637 is one of the "Albar" cottons which have been distributed from the Namulunge Research Station in Uganda and have, as their main characteristic, a resistance to bacterial blight which attacks the cotton plant most severely in hot and humid conditions.

In Nyasaland, A637 has been proved the best of a group of Albars tested over the last two seasons on the experimental stations. Both 1955 and 1956 were wet years, with heavy blackarm infection in the trials, and the resistance of A637 enabled it to outyield CLB by more than 30 per cent.—in some cases it yielded over twice as much as CLB. In the 1957 season trials were carried out in all the cotton growing districts, both at research centres and in African cotton gardens. The final yield figures for the average of 175 plots are given below with the ginning return for an average of 8 roller ginned samples from the Lower River. (Commercial saw ginning gives approximately 2 per cent. less.)

Variety	Seed cotton lb. per acre	Yield % of CLB	Ginning outturn
			%
CLB	617	100	32.4
CL20	603	98	31.7
A637	706	114	33.9

1957 was a dry season and blackarm damage was practically nil. Yield differences would have been much greater in a wet season.

Spinning tests over the last two seasons have shown that A637 has a staple length approaching  $1\frac{1}{8}$  in. as compared with 1 in. for CLB, and produces a stronger yarn.

The strain CL20, a selection from CLB, had previously been considered as a replacement for the latter, since its spinning qualities are superior to those of A637. The season's trials showed, however, that in yield and ginning outturn and in jassid resistance it rates below CLB.

In view of the all round record of A637, therefore, it has been decided not to proceed any further with CL20, but to go ahead as quickly as possible with the multiplication of A637. Enough seed for the requirements of the entire country should be available by 1961/62.

### **South Africa**

**75.** Figures received from the Government grader show that the final cotton ginning returns are estimated at 30,000 bales of lint (500 lb.) compared with a crop of 28,000 bales for the previous season.

Particulars for the various areas are as follows:

	<i>1955-56</i>	<i>1956-57</i>
	<i>(Revised)</i>	<i>(Final)</i>
Natal, Swaziland and Zululand	7,500	8,000
Eastern Transvaal	.. ..	5,000
Orange River area	.. ..	15,000
Other areas	.. ..	500
	28,000	30,000

Good rains have fallen throughout the Eastern Transvaal Lowveld and in the Upington area, and there are indications that a record crop will be reaped this season.

### **COTTON IN THE AMERICAS**

#### **United States**

**76. 1957-58 Season.** In February the Department of Agriculture forecast a further decline in the cotton crop, the estimate indicating an output of 11,010,000 bales compared with 11,788,000 bales announced in January. The estimated yield per acre has dropped from 413 lb. at the beginning of November to 390 lb. The season's American-Egyptian crop is calculated at 81,000 running bales, compared with last season's 50,300 bales.

**1958-59 Season.** Cotton farmers have been warned by the Secretary for Agriculture that cotton acreage allotments might drop to around 13 million acres (about 25 per cent. below the present minimum) in 1959, when the legislation which established the present minimum of about 17,600,000 acres would expire. After that date the allotment would be set at a total acreage which normally would produce a crop of 10 million bales.

The 1958 planted acreage, allowing for announced Soil Bank withdrawals, will be around 14 million acres, and may be reduced further if Soil Bank funds are increased by Congress. Such a small acreage could result in an acute shortage of desirable grades and staples in the following season should weather conditions again be unfavourable,

as the CCC stocks of desirable White grades will be virtually exhausted at the end of the present season, and the new crop will be the only source of supply.

The Department of Agriculture is reported to be planning a cotton export subsidy next season payable in kind. This subsidy may be flexible and paid in undesirable spotted and off-coloured cottons from the CCC stocks at big price discounts.

In 1957 cotton farmers placed about 3 million acres in the Soil Bank at an average rate of \$54.15 per acre. The national average payment rate for 1958 has been announced at \$58.95 per acre, and the Soil Bank target has been set at 2.7 to 3.7 million acres.

**77. Texas Releases Austin Cotton** (*What's New Crops Soils*, 9, 8, 1957, p. 28. From *Pla. Bree. Abs.*, 28, 1, 1958, p. 119.) The Texas Agricultural Experiment Station has developed an open-boll type of cotton from Stoneville 20 x Empire back crossed to Empire. It is highly resistant to race 1 of bacterial blight and tolerant to race 2 and the wilt-nematode complex. Under disease conditions it gives yields 5-100 per cent. better than other open-boll varieties. It gives satisfactory yields under drought conditions but performs best under normal rainfall or irrigation. Its staple length is  $\frac{3}{2}$  in. to  $\frac{3}{3}$  in. with fibre satisfactory for yarn, and seed of good quality for cottonseed products.

**78. Mexico.** Mexican cotton production in 1957-58 is estimated at 2,014,000 bales (500 lb.). This is the second largest crop on record and shows a 13 per cent. increase over the previous season.

#### West Indies Federation

**79. 1957-58 Season. Antigua.** Of the estimated 4,893 acres planted with cotton, 4,000 were sown with MSI, 876 with VH8 and 17 with VH10. Harvesting began in February and with favourable conditions a record crop of about 2,590 bales (400 lb.) may be expected.

**Montserrat.** The crop is estimated at 750 bales.

**Nevis.** In Nevis 3,000 acres were planted with cotton. Germination was good and the crop is progressing satisfactorily. A crop of 1,062 bales is expected.

**St. Kitts.** Approximately 877 acres were planted from which it is hoped to harvest 575 bales.

**St. Vincent.** It is expected that about 500 bales will be produced as compared with 430 bales produced in 1956-57.

#### COTTON IN ASIA AND AUSTRALIA

##### Israel

**80.** The first export of Israeli cotton on a commercial scale has been shipped to England. The consignment, 400 bales (500 lb.) of long staple Pima, is valued at more than £100,000. This price exceeds the world price for this type of cotton, but spinners are said to have agreed to it in order to encourage cotton growing in Israel. The 1957 crop of 800 bales has also been sold to England.

It is expected that the territorial crop, estimated at approximately 4,000 tons, will meet about two-thirds of the needs of local manufacturers.

##### India

**81. 1956-57 Season.** The final all-India estimate of the cotton crop

issued by the Ministry of Agriculture gives staple length distribution as follows:

		<i>1955-56</i>	<i>1956-57</i>
Long Staple $\frac{7}{8}$ in. and above .. ..		1,610,000	1,938,000
Medium staple 'below $\frac{7}{8}$ in. and above $\frac{11}{16}$ in.) .. .. ..		1,692,000	2,007,000
Short staple $\frac{11}{16}$ in. and below .. ..		699,000	778,000
<hr/>			
Total.. .. ..		4,001,000	4,723,000

*1957-58 Season.* In February the crop was estimated at 4,900,000 bales. The estimate of domestic consumption was around 4,650,000 bales, while exports were expected to reach 200,000 bales. In 1957 exports of cotton piece goods amounting to 470 million square yards made India the second largest exporter of cotton textiles in the world.

**82. New and Improved Strains for Indian Cotton Growing Areas.** (*Indian Farming* and *Ind. Cott. Gr. Review.*) *Bombay.* The new strain CJ73 has been selected from the cross C520 x Jarila. In trials over three years, CJ73 outyielded Pratrap, the existing commercial strain grown in the Mathio tract of Kathiawar, by about 80 lb. of seed cotton per acre. It was shown to be earlier than Pratrap in boll opening by about a week and more resistant to wilt. Moreover it was distinctly superior in fibre and spinning properties.

*Madras.* A new strain, 6186-9, has been evolved for commercial cultivation in the Tinnevelly and Karunganni tracts which extend over 400,000 acres in the southern and central districts of the Madras State. Whereas the existing strains K2 and K5, grown in the centre and south respectively, possess a staple length of  $\frac{7}{8}$  in., ginning outturn of 31 to 32 per cent. and spin 32's with a yield of 101 lb. of lint per acre, the new strain has a staple length of  $\frac{15}{16}$  in., ginning outturn of 33 per cent., spinning capacity of 34's and an average yield of 126 lb. per acre. 6186-9 is now being multiplied on the Agricultural Research Station at Koilpatti.

Elsewhere in Madras State cotton growers have increased their gross profit by nearly Rs.56 per acre by growing the new long staple cotton MCU2 (Madras Uganda No. 2). The new cotton is best suited for growing in the summer season from March to mid-August, and as it matures within the short space of five to five-and-a-half months it can be grown in rotation with paddy. It has a staple length of  $1\frac{1}{16}$  to  $1\frac{1}{8}$  in., and is suitable for spinning 36's to 38's, having a count x strength product of 1797 at 30's and 1519 at 40's and a Pressley strength index of 7.03. It is considered to be one of the best quality cottons at present grown in India on a commercial scale. It yields about three-quarters of a bale of lint per acre, and has a ginning outturn of 34 per cent. Multiplication and distribution of the seed is controlled by the Indian Central Cotton Committee in association with the State Government.

*Mysore.* Trials carried out with the Sea Island cotton Andrews on the West Coast of Mysore continue to give promising results. Yields of 1,615 lb. of seed cotton per acre have been obtained, with fibre properties superior to those of imported Karnak. The best yields have been obtained when Andrews was grown as pure stand with a basal application of 3 tons of farmyard manure, 90 lb. of superphosphate

and 50 lb. of potash in combination with a topdressing of 40 lb. of nitrogen per acre. Under these conditions farmers can obtain an average profit of Rs.500 to Rs.600 per acre.

Other long staple varieties under trial in Mysore are LL56 and the Egyptian types Giza 7 and Giza 12.

**83. Cotton Improvement in India.** K. M. Simlote Institute of Plant Industry, Indore, 1956. The foreword by the President of the Indian Central Cotton Committee commends the book as a record of the achievements of the Committee and the State Departments of Agriculture in introducing improved varieties in nearly two-thirds of the total area under cotton in India. The author, who has worked on cotton breeding for over twenty years at the Institute, states that more than three-quarters of total cotton production stapled above  $\frac{1}{2}$  in. in 1953-54 as against only one-third in 1920. Details of the botanical and technological characteristics of Indian varieties and the conditions and methods of cultivation are followed by an outline of the techniques employed by the plant breeders. The cotton breeding schemes in eleven States are described individually, with a general appraisal of the effects of the cotton extension programme started in 1951, when production totalled just under 3 million bales compared with just under 4 million in 1953-54.

Also included are notes on some important pests and diseases and their control, the constitution and functions of the Indian Central Cotton Committee, and the agricultural and commercial characteristics of the improved varieties. The general index is supplemented by an index of varieties, a short glossary and a list of cotton breeding stations in India.

**84. Technological Research on Cotton in India. A Résumé of the Work carried out at the Technological Laboratory during the Period 1926-56.** C. Nanjundayya. (Tech. Lab. Ind. Cent. Cott. Cttee. 1956. Pp. 205. Price Rs.3.) The important activities of the Laboratory and the main conclusions drawn from the various research investigations on ginning, fibre and yarn properties and spinning technology undertaken to date are summarized in this publication. Reports are included also on tests carried out for cotton breeders and for the cotton trade and industry.

**85. Sixth Conference on Cotton Growing Problems in India. February 1955.** (Ind. Cent. Cott. Cttee., Bombay, 1955. Received 1957.) In view of the large number of papers submitted at the Conference, only abstracts of the papers and the resulting discussions are included in this report. The full papers are being published in the Committee's quarterly journal, the *Indian Cotton Growing Review*. The papers are grouped as follows: cotton breeding and genetics, cotton statistics, cotton technology, cotton agronomy and cotton pests and diseases.

#### **Pakistan**

**86.** The third official estimate of the area under cotton for the 1957-58 season is 3,410,000 acres (American varieties 2,914,000 and Desi 496,000) an increase of 1.3 per cent. on the previous year.

The production of cotton for 1957-58 is estimated at 1,580,000 bales of 400 lb. (American 1,387,000 and Desi 193,000). This shows an increase of 4.2 per cent. on the previous year.

**87. Pakistan's Expanding Cotton Industry.** *New Commonwealth, 3/2/58.* On partition from India in 1947, there were in Pakistan only 17 mills with 177,418 spindles and 4,824 looms. Production of cloth averaged about 1·5 yards per head of the population. Today there are more than 100 mills working over 2 million spindles and about 30,000 looms. The domestic requirements of coarse and medium quality cloth are fully covered, and the export surplus of yarns and cloth through the year ending July 1957 was valued at Rs.100 million.

The development of the industry owes much to government protection, and an export incentive scheme is now being introduced giving concessions to the industry to enable it to compete in foreign markets.

Although cotton is West Pakistan's only major cash crop, it is unlikely that a concerted effort to improve its quality would have been made if the mills had not demanded more and better cotton. Consumption has now risen to nearly a million bales a year—a little over half the total production—and research schemes to improve quality and increase yield are well established. A number of long-staple varieties have been developed and introduced to the farmer, and the area under American varieties has increased by 500,000 acres.

Attention is now being directed towards the production of fine quality yarn and cloth. Under the existing Five Year Plan mills are being equipped for this purpose. The cost of expansion during the Plan period is estimated at Rs.213 million, and a further Rs.38 million are to be spent on the modernization of the existing plant. By 1960 the production capacity is expected to reach 1,150 million yards a year, with enough fine cloth to meet the home demand.

**88. Pakistan Soil Survey** (*Pakistan News, 4/1/58.*) The soil fertility survey sponsored by the Ministry of Agriculture is expected to start in West Pakistan early in 1958. It has already started in East Pakistan. The scheme is designed to establish the fertility levels of the soils and their fertilizer requirements.

### Australia

**89. Queensland. 1956-57 Season.** In the Annual Report of the Department of Agriculture and Stock it is stated that although seed sufficient to plant about 18,000 acres was supplied for the 1956-57 season, it was expected that only 9,000 acres would be harvested owing to the failure of planting rains.

In trials of rain-grown cotton at Biloela Experiment Station the varieties Miller 610, Miller 51S and Empire gave the best yields, averaging 500 lb. seed cotton per acre.

In the "small farm" rotation trials (four years of Rhodes grass followed by cotton-sorghum-cotton) cotton following sorghum in the third year after the grass phase yielded 472 lb. seed cotton per acre, against only 445 lb. per acre for cotton in the first year after grass. In the "large farm" trials (four years of grass followed by cotton-cotton-sorghum-cowpeas and a cereal) the yield from cotton in the first year after grass was 723 lb. per acre.

With irrigation and side dressings of 2 cwt. sulphate of ammonia applied in early December and again in January, yields of 2,570 lb. per acre were obtained, the net gain due to fertilizer treatment being valued at £29 11s. per acre.

**GINNING AND GINNORIES**

**90. Relationship of Lint Quality and Moisture through Harvesting and Ginning.** R. A. Montgomery and O. B. Wooten. (*Cotton Gin and Oil Mill Press*, October 19, 1957. From *Text. Tech. Digest.*, **14**, 11, 1957, Abstract 3093.) When two lots of cotton were stored in trailers for a period of time before ginning and were given equal drying in the gin, the bales made from cotton picked in the early morning were almost a full grade lower than those from cotton picked in the afternoon. A major part of the grade difference appeared to be associated with loss of colour while the cotton was stored in trailers. The delay in ginning (12 to 72 hours) in this test was comparable to the normal delays at commercial gins.

**91. A Comparative Study of the Commercial and Laboratory Valuations of Cotton Lint produced with Cleaning before and after Ginning.** C. Nanjundayya and R. L. N. Iyengar. (*Ind. Cott. Gr. Rev.*, **11**, 3, 1957, p. 1.) For this investigation varieties containing a fairly wide range of trash content were selected. Although cleaning the lint in a Crighton opener before baling improved the grade and reduced blow-room loss during spinning, the premium paid for the improvement was too small to compensate for the loss in weight and the expenses incurred except in the circumstances where a mill gets its supply of cotton from its own ginning factory.

**SOILS, FERTILIZERS AND CULTIVATION**

**92. A Rainfall Test for Structure of Tropical Soils.** H. C. Pereira. (*J. Soil Sci.*, **7**, 1, 1956, p. 68.) The ability of the soil surface to accept continuous heavy rainfall is a critical factor in the prevention of accelerated erosion of tropical soils. The qualities required in the soil are complex, and are not easily inferred from simple laboratory measurements. A direct test has therefore been developed for this property. Large soil cores of undisturbed structure are brought to a standard moisture tension and are subjected to heavy artificial rainfall of controlled drop-size and intensity. The drainage tension is maintained at a constant value, and the rate of infiltration is measured. The apparatus is described in detail. Examples of results from a tropical rotation experiment are given, in comparison with pore-space and percolation measurements.

**93. Influence of Timing of Irrigation on Yield, Quality and Fruiting of Upland Cotton.** A. E. Spooner *et al.* (*Agron. J.* **50**, 2, 1958, p. 74.) A study to determine the effects of timing of irrigation treatments on the yield, quality and fruiting of Upland cotton was conducted in 1955 and 1956 at the Experiment Station, Fayetteville, Arkansas.

The treatments were:

1. Control (no irrigation).
2. Irrigation started when the first bolls were twenty days old and continued through the remainder of the fruiting season.
3. Irrigation started at first bloom and continued through the remainder of the fruiting season.
4. Irrigation as needed throughout the season.

After each irrigation cycle was started the soil moisture was not

allowed to drop below 50 per cent. available moisture for the remainder of the fruiting season.

Increased yields amounting to approximately a bale per acre were obtained from all treatments. It was also noted that maturity was delayed by irrigation; the peak of fruiting was extended by approximately two weeks; shedding was significantly decreased by irrigation and boll size significantly increased; proper irrigation stabilized and generally improved lint quality.

**94. Defoliation and Desiccation: Harvest-Aid Practices.** F. T. Addicott and R. S. Lynch. (*Advances in Agronomy*, 9, 1957, p. 67.) This review discusses methods of chemical defoliation and desiccation and the basic factors which underlie these practices as conducted on a number of field crops. The importance of defoliation to the cotton crop has increased with the spread of mechanized harvesting, and in 1955 nearly 3 million acres of cotton in the United States were so treated.

Good results depend largely on the uniform distribution and development of the plants and on efficient weed control. The most difficult problem is determination of the time of application, since early application will reduce yield and fibre quality, while late application risks poor response and fibre deterioration. It is generally recommended that application should be delayed until the youngest bolls are at least forty days old. When cotton is rank, however, early bottom defoliation may be used to reduce boll rot and accelerate the opening of lower bolls. In some areas defoliation may be successfully carried out by withholding irrigation.

In the high plains of Texas and Oklahoma where relatively low yields call for lower production costs and the crop is harvested with mechanical strippers which remove the leaves and burs with the seed cotton, desiccation is a standard practice, since it eliminates leaf staining of fibre though adding considerably to the trash content of the seed cotton.

#### MACHINERY AND MECHANIZATION

**95. Continuous Process Baling Press.** (*Text. Mfr.*, 83, 1957, p. 457. From *B.C.I.R.A. Summ. Curr. Lit.*, 37, 22, 1957, p. 701.) A new machine for baling fibres has been marketed by Messrs. Joseph Newsome and Sons Ltd. The machine consists of two vertical steel cages suspended from the ceiling. The material to be baled is fed into the cages from the top, the bale cover or bag being clamped at the bottom of each cage. Compression is by means of a heavy weight which can be passed from one cage to the other, so that while one cage is being filled the material in the other cage is being compressed, making the operation continuous.

#### PESTS AND DISEASES

**96. Studies of Crop Loss following Insect Attack on Cotton in East Africa. I.—Experiments in Uganda and Tanganyika.** K. S. McKinlay and Q. A. Geering. (*Bull. Ent. Res.*, 48, 2, 1957, p. 833.) The loss of crop following insect attack on cotton was studied in 1950-54 at the Cotton Research Station, Namulonge, in the elephant grass zone of Uganda where the principal pest was originally considered to be *Lygus vosseleri*. The bollworms *Heliothis armigera* and *Earias* spp. were also important pests, their attacks following those of *Lygus*. Experiments devised to evaluate the effects of these pests showed that

on early sown cotton (June 10) chemical protection from insect attack for the maximum period of four months did not increase yield, but caused the crop to form earlier, whereas on late sown cotton August 10 protection by insecticides was accompanied by increases in yield in all localities, although maximum protection did not necessarily give the greatest increase.

These results indicate that where a sufficiently long growing season can be achieved by early sowing, the plant can replace a considerable loss of flower buds and bolls to the extent that total yield is unaffected.

In order to investigate the situation in an area with a single rainy season, shorter growing period, and more intense insect attack, two experiments were conducted at Ilonga, in eastern Tanganyika, where infestations of cotton by *H. armigera* were usually severe. Under these conditions results showed that early sown cotton could recover from considerable loss of fruiting bodies, although late sown cotton had less chance of recovery from such damage than it had in Uganda.

From these results and the findings of experiments conducted elsewhere, it is concluded that only when insect damage exceeds the point at which recovery is still possible will insecticides increase yields. Any factors tending to reduce the length of the growing season, or any increase in severity in the insect attack, will reduce the plant's powers of recovery and emphasize the need for insecticidal control, but it is evident that the presence of insects feeding on cotton does not always mean that such control would be necessary or profitable.

**II.—Further Experiments in Uganda.** T. H. Coaker (*Bull. Ent. Res.*, **48**, 2, 1957, p. 851.) The study of crop loss following insect attack on cotton in Uganda described in Part I above was continued through 1954-56. Analysis of the cause and incidence of shedding of developing fruit bodies showed that the total amount of shedding was roughly the same whatever the treatment, that due to insect damage tending to be balanced by that due to other causes, which were probably physiological in nature. There was thus some over-riding factor, other than pest attack, that governed the crop finally held by the plant. Damage caused by insects to older bolls which do not shed constitutes a real loss that is reflected in the final harvest. The proportion of clean seed cotton was higher in the treated plots, particularly in the early sown cotton, in which analysis of the harvested locules showed that the damage was predominantly due to bollworm, but there were no significant differences in yield between the various insecticide treatments in either early or late sown cotton.

**97. The Biology of Three Chrysopid Predators of the Cotton Aphid.** H. B. Burke and D. F. Martin. (*J. Econ. Ent.*, **49**, 5, 1956, p. 698. From *Rev. App. Ent.*, **45**, Ser. A, 11, 1957, p. 436.) *Chrysopa rufilabris*, *C. plorabunda* and *C. oculata* were observed in fields of cotton infested by *Aphis gossypii* near College Station, Texas, in the summer and autumn of 1954. *C. rufilabris*, which was the principal species, was present on cotton in August and September; adults and larvae were collected on *Sorghum halepense* in October and November, and adults but no immature stages on lucerne in December and January. Females taken in early February deposited a few eggs, and eggs and larvae were found on oak in early March. *C. plorabunda* was found on *S. halepense* and weeds after it decreased on cotton; adults were abundant on lucerne throughout the winter, but larvae were observed in November and then not again until March. Larvae and adults of *C. oculata*, which was the

least abundant, were collected in November on plants other than cotton and then not again until March. Laboratory tests showed that the larvæ of this species pupated in the soil, and laboratory-reared third-instar larvæ that were caged out of doors on December 23 constructed cocoons about 3 in. below the surface by the end of the month; about half died in the prepupal stage, and the remainder pupated in mid-February, one adult emerging on February 27. It is concluded that *C. oculata* overwinters in the prepupal stage in the soil.

In the laboratory, the egg, larval, prepupal and pupal stages of *C. rufilabris* averaged nearly 4, 8, 3 and 7 days respectively, those of *C. plurabunda* about 5, 10, 4 and 8 days, and those of *C. oculata* about 5, 10, 6 and 11 days. Males and females of the three species lived for averages of 23·4 and 23·6, 34·6 and 62·4, and 26·4 and 22·9 days, respectively, and the average numbers of eggs deposited per female were 31·2, 32 and 185·4. Larvæ of all eggs deposited fed voraciously on *A. gossypii* in the laboratory, consuming average numbers of 268·6, 208 and 265·6 respectively, during life. The adults of *C. oculata*, but not of the others, also attacked the aphid, one devouring 453 in ten days.

**98. Control of the Cotton Aphid and Cotton Leafworm with Phosphorus Insecticides.** J. W. Davis *et al.* (*J. Econ. Ent.*, **49**, 5, 1956, p. 706. From *Rev. App. Ent.*, **45**, Ser. A, 11, 1957, p. 439.) An account is given of investigations carried out mainly in the autumn of 1955, on the control of heavy infestations of *Aphis gossypii* and *Alabama argillacea* on cotton in central Texas with several new and established phosphorus insecticides.

**99. Studies on the Control of Boll Weevils in Surface Woods Trash.** R. L. Walker and A. R. Hopkins. (*J. Econ. Ent.*, **49**, 5, 1956, p. 696. From *Rev. App. Ent.*, **45**, Ser. A, 11, 1957, p. 436.) In the south-eastern United States, *Anthonomus grandis* commonly hibernates in surface débris in woods, mainly within 50 ft. of the perimeter, and investigations were carried out in South Carolina in 1954-55 on the control of the overwintering adults by means of granular insecticides.

In 1954, wooded areas were treated to a depth of 200 ft. from the edge with heptachlor, toxaphene, chlordane or dieldrin at 4 lb. per acre, applied by aeroplane in March, and examination of samples of débris taken from the woods in January-February and in April showed the presence of 968, 1,694 and 2,904 living weevils before and none after treatment with the first three materials, and of 564 before and 387 after treatment with dieldrin, a reduction of 31 per cent., whereas there was a natural mortality of 40 per cent. in untreated woods. Cotton fields in the treated area were examined for weevils on May 5, 11 and 20, and 17, 15 and 21 were found per acre, as compared with 102, 83 and 26 in similar fields in an untreated area.

In a further test, 500 field-collected weevils were put in each of a number of cages over débris at the edge of a wooded area in October, 1954, and granules were applied uniformly to the surface of the débris on March 1, 1955. Counts of the weevils that appeared between March 1 and June 24 showed percentage emergences of 6 and 3·4 for treatment with 2·5 and 5 lb. dieldrin per acre in 10 per cent. granules, 0·8 and 0·4 per cent. for 5 and 10 lb. gamma BHC in 5 per cent. granules, and 15·4 per cent. for no treatment, indicating net kills of 61, 77·9, 94·8 and 97·4 per cent. for the four insecticide treatments. The difference between the BHC treatments was not significant, but the other differences were highly significant.

**100. Some Remarks about *Diparopsis castanea* in Mozambique.** A. J. F. Castel-Branco. (*Gaceta del Orta*, 3, 2, 1955, p. 225. From *Rev. App. Ent.*, 45, Ser. A, 12, 1957, p. 493.) *Diparopsis castanea* is a serious pest of cotton in Portuguese East Africa, where it has been estimated to destroy about 32 per cent. of the potential crop. All stages of this noctuid are described, and the results are given of observations in the field and laboratory on its bionomics.

There were three generations a year, emerging mainly in March, May and December-January, respectively. Few adults were present after July. Pairing occurred during flight and did not take place in the laboratory. Only fertilized females oviposited, but those kept in captivity rarely laid more than 100 eggs each, though unfertilized females contained about 450. The eggs were laid singly on the plants in the evening and all hatched. The newly hatched larvæ were agile and rejected all food except germinating cotton seeds and leaf or flower buds. They died in twenty-four hours if food was not available. Attacked buds dried up. In the second and third instars, the larvæ fed in young bolls, in which they attacked the developing seeds, later migrating to others. The fourth and fifth instar larvæ attacked older bolls. The larval stage lasted nearly a month, and the prepupæ fell to the ground and entered the soil to pupate. Pupal cells were formed in damp soil, but not in dry loose soil, and high temperatures and lack of shade were unfavourable for survival of the prepupæ. The duration of the pupal stage was found to vary with the temperature at which the eggs were incubated. Eggs incubated at temperatures ranging between 4° and 14° C. gave rise to long-cycle pupæ, whereas eggs from the same parents incubated at atmospheric temperature (about 28° C.) gave rise to short-cycle pupæ. The usual duration of the pupal stage was 20-30 days. The adults emerged in the morning and were ready to fly by nightfall. During the day they are immobile.

No natural enemies of the eggs were observed. The larvæ were destroyed by birds and lizards, and 13.5 per cent. of the pupæ were attacked by an unidentified species of Hymenoptera. The adults were destroyed by birds and also by small ants. Spraying in March 1953 with an emulsion concentrate containing 25 per cent. parathion diluted to 0.25 per cent. about doubled the yield.

**101. *Earias insulana* and *Tetranychus telarius* on Cotton in South Western Persia.** M. Salvatian. (*Ent. Phytop. Appl.*, Teheran, 16/17, 1957, p. 17. Abs. from French summary from *Rev. App. Ent.*, 45, Ser. A, 12, 1957, p. 463.) *Earias insulana* and *Tetranychus telarius* are serious pests of cotton in Khuzistan, south-western Persia, where the former produces five generations during the cotton season and infests some 56 per cent. of the buds and 64 per cent. of the bolls in autumn. They are less injurious at Garmsar, near Teheran, where *E. insulana* produces four generations during the season and passes the late autumn and winter in the pupal stage.

Tests on the control of the two pests were carried out in both areas in 1954-55. Sprays of barium fluosilicate were ineffective against *Earias*, and of the various organic materials tested, endrin at 0.45 lb. and systox at 0.225-0.27 lb. in 18-31.5 gals. of water per acre in spring and 56-72 gals. in autumn gave the best control of *Earias* and the mite, respectively, retaining their effectiveness for two and four weeks, and more than tripled the yield in Khuzistan.

**102. The Spring Generation of the Cotton Noctuid in the Murgab Valley, Turkmenia.** P. P. Bogush. (*Rev. Ent. U.S.S.R.*, **35**, 1, 1956, p. 80. From *Rev. App. Ent.*, **45**, Ser. A, 11, 1957, p. 423.) Although most of the pupæ of *Heliothis armigera* 'Chloridea obsoleta' Auct. overwintering in Turkmenian cotton fields are destroyed by ploughing in spring, this noctuid appears on cotton in numbers about June every year, indicating that considerable populations persist elsewhere. The overwintering pupæ have been found capable of resuming development at 15.5° C. (59.9° F.) in the laboratory, and since the temperature in the south of Turkmenia, notably in the valley of the Murgab, reaches that level by April, it was thought that a spring generation of the moth may develop in the valley. This view was supported by the yearly taking of adults in light-traps from February 25 to May 6.

In investigations in 1951-53, overwintering pupæ kept in cages in the soil in a lucerne field from October-November and taken to the insectary between the end of February and mid-May gave rise to adults in April-May. Eggs were collected in the field in the early spring of 1953, and larvæ were numerous in May on various plants including tomato, cotton, chick pea and lucerne in several years. When taken to the laboratory, they gave rise to adults in late May or June. The occurrence of a spring generation was thus apparently a regular phenomenon in the area. Lucerne fields were found to be the principal source of the moths that migrate to cotton and larvæ were observed in them in May feeding not only on lucerne but also on *Chenopodium album* and the flowers of *Convolvulus arvensis*.

**103. Influence of Irrigation and Fertilizer on Populations of Three Species of Mirids attacking Cotton.** P. L. Adkisson. (*F.A.O. Pla. Prot. Bull.*, **6**, 3, 1957, p. 33.) Cotton growers in the U.S. cotton belt are greatly concerned over the infestations of three species of mirids: i.e. cotton fleahopper, *Psallus seriatus*, rapid plant bug, *Adelphocoris rapidus* and tarnished plant bug, *Lygus lineolaris*. In areas where measures to increase yields are concentrated on irrigation, higher rates of fertilization and pest control practices, recent investigations indicate that populations of the cotton fleahopper and other mirids may be influenced by irrigation or rainfall, and that they are attracted to fields having succulent plants.

At Sikeston, Missouri, a split plot design combining irrigation with several fertilizer rates was used to study their influence on mirid populations. Results showed no significant differences in the insect counts among the plots until drought symptoms became evident. Then the highly fertilized, irrigated plots showed much heavier infestation than the non-irrigated plots with lower fertilization rates. In nearly all cases there were more insects present in the irrigated fertilizer treatments than in their non-irrigated counterparts, but differences in populations among the treatments were due to both fertilizer and irrigation. Although no insect control was practised, good yields were obtained from the fertilized irrigated plots.

**104. Chemical Control of Pink Bollworms Overwintering in the Soil.** I. Shiller and A. J. Chapman. (*J. Econ. Ent.*, **49**, 5, 1956, p. 718. From *Rev. App. Ent.*, **45**, Ser. A, 11, 1957, p. 443.) In tests in Texas in 1944 and 1953-55 on the possibility of reducing the survival of larvæ of *Platyedra gossypiella* overwintering in cotton bolls left in the field, weighed quantities of open infested bolls were buried in the soil under cages equipped with traps, and the effectiveness of different

insecticide treatments was based on emergence records from treated and untreated lots.

In 1944 the bolls were buried at depths of 2, 4 and 6 in. and a 1:1 emulsion of D-D (a proprietary mixture of 1,3-dichloropropene and 1,2-dichloropropane) and water was poured into furrows 1.5 in. deep and immediately covered with soil. Treatment with the emulsion at rates of 25.5, 51 and 102 U.S. gals. per acre reduced emergence by 42, 82 and 89 per cent., respectively, as compared with no treatment.

In 1953-54 the bolls were first sprayed with emulsions at a rate equivalent to 25 U.S. gals. per acre and then buried 2 in. deep, and it was found that 6 lb. gamma BHC, 8 lb. endrin and 10 lb. parathion, aldrin or heptachlor per acre reduced emergence by 90-97 per cent.; in 1954-55, similar treatment with these materials, except that heptachlor was used at 20 lb., and with 8 lb. gamma BHC and 10 lb. isodrin, reduced it by 65 to 90 per cent. Treatment in one or other year with 10 lb. diazinon or dieldrin, 16 lb. EPN, 2-16 lb. Bayer L 13/59, 20 lb. strobane or DDT and 21 lb. chlordane per acre caused lower but significant reductions, and 15 lb. malathion, 10 lb. chlorthion or am. cyanamid 4124 and 30 lb. parathion were ineffective.

**105. Polyhedrosis-Virus Disease on Cotton Leafworm, *Prodenia litura*.** S. Abul-Nasr. (*Bull. Soc. Ent. Egypte*, 40, 1956, p. 321. From *Rev. App. Ent.*, 46, Ser. A, 1, 1958, p. 27.) Larvæ of *Prodenia litura* in Egypt are attacked by a polyhedral virus disease that sometimes causes high field mortality. Laboratory tests, in which larvæ were infected by feeding them on leaves of berseem dipped in suspensions of the polyhedra, showed that the disease developed rapidly in summer and slowly in winter, larvæ usually dying 4-5 days after feeding in summer and showing full symptoms only after 10-12 days, if at all, in winter.

High relative humidity increased the virulence of the disease and reduced the incubation period. Suspensions of 5-10 million polyhedra per ml. were sufficient to infect larvæ in the third or later instars, but concentrations of 50-100 million per ml. were necessary to infect those in the first instar and 20-50 million for those in the second.

Field-collected larvæ that were reared singly under sterilised conditions in the laboratory showed that natural infection reached 5 per cent. on berseem in spring, 10-20 per cent. on cotton in summer and over 25 per cent. on maize in late summer, when the high temperature and humidity and the heavy larval populations favoured the disease. The symptoms of the disease and its effects on the internal tissues of the larvæ are described.

**106. Occurrence of Red Coffee Borer, *Zeuzera coffea* on Sea Island Cotton at Pattambi, S. Malabar.** T. R. Subramanian. (*Int. J. Ent.*, 18, 2, 1956, p. 195. From *Rev. App. Ent.*, 45, Ser. A, 12, 1957, p. 502.) *Zeuzera coffea*, which has a wide range of food plants and has been reported from tea and coffee in Southern India, was observed in November 1955 attacking Sea Island cotton, which had recently been introduced on the west coast of Madras. The larvæ bored in the main stems and caused the leaves and shoots to wither. Only small numbers of plants were attacked, but it is feared that the cossid may increase in importance if neglected.

**107. Nocturnal Activity of Insects as Indicated by Light Traps.** M. H. Hassanein. (*Bull. Soc. Ent. Egypte*, 40, 1956, p. 463. From *Rev. App. Ent.*, 46, Ser. A, 1, 1958, p. 29.) Investigations on the nocturnal activity, abundance and population density of insects in the field at

Shebin El-Kom, Egypt, were made by means of two light traps operated through 1952 and with four in 1953. The average catch was highest in July and lowest in January. Diptera and Homoptera comprised about 78 and 14 per cent., respectively, of the total catch, and Lepidoptera and Coleoptera about 2·8 and 2·2 per cent. Special attention was devoted to Lepidoptera of economic importance. *Prodenia litwa*, the main pest of cotton and clover in Egypt, was taken in all months and was most abundant in June and July. There appeared to be five overlapping generations a year, and females comprised 47 per cent. of the total. *Laphyrgma exigua* was taken from March to December; it had six generations a year, and males and females occurred in almost equal numbers. Four generations of *Agrostis ypsilon* developed between late September and mid-July, and its absence in August confirmed earlier findings of its migratory habit; numbers were greatest in April, and 52 per cent. of the adults were females. *A. spinifera* was present throughout the year and was caught in large numbers from spring to autumn, 45 per cent. of the catch being females, and *Earias insulana* reached a peak of activity in September and October, males being three times as numerous as females.

Several species appeared to have two generations a year. Of these, *Autographa gamma* was unusually abundant in March and April, and records of mass flights at this time indicate that it is migratory in Egypt; females and males were about equal in numbers in this species and in *Heliothis armigera*. The ratio of males to females was 3 : 2 for *Chilo suppressalis*, which was most active in October, and 4 : 1 for *Pyrausta nubilalis*, which was abundant during September and October.

**108. Field Tests with New Materials against Cotton Insects at Tallulah, Louisiana, in 1955.** T. R. Pfrimmer and R. C. Gaines. (*J. Econ. Ent.*, **49**, 5, 1956, p. 712. From *Rev. App. Ent.*, **45**, Ser. A, 11, 1957, p. 441.) The results are given of trials with several new organic insecticides on cotton in Louisiana in 1955 for the control of *Anthonomus grandis*, which was much the most important insect present, *Heliothis zea*, which did not become abundant until after mid-August, *Aphis gossypii*, which had become very numerous in some plots by that time, and spider mites, which were unimportant.

**109. Thimet, a New Systemic Insecticide for Cotton.** (*World Crops*, **10**, 2, 1958, p. 68.) A new systemic insecticide known as thimet has been produced by the American Cyanamid Company. This chemical is coated on to the cotton seed prior to sowing and enters the sap system at the time of germination. It is fatal to chewing and sucking insects feeding on the plant for several weeks through its early growth. Great caution must be used in applying thimet, however, as it is highly poisonous to man and animals. A test carried out in the São Paulo area in Brazil showed that the use of thimet resulted in a 20 per cent. yield increase in cotton.

**110. Control of Seedborne Infection of Anthracnose of Cotton in Bombay State.** V. P. Bhide *et al.* (*Ind. Cott. Gr. Rev.*, **11**, 4, 1957, p. 496.) Anthracnose of cotton caused by *Colletotrichum indicum* has since 1953 assumed such serious proportions as to become a limiting factor in the successful cultivation of Virnar cotton, the main cash crop of the Khandesh region of Bombay State. The disease manifests itself as both seedling rot and boll rot.

In pot culture tests at Poona in 1955-56 for evaluating the efficacy of mercurial and copper seed disinfectants for the control of seedborne

infection, organic mercurial disinfectants containing 1 per cent. of the active ingredient gave excellent control when applied at a level of 2 oz. to 15 lb. of cotton seed.

This dosage of the organic mercurial fungicide was tried on a field scale in 1956-57 in three compact blocks each of about 1,000 acres. The treatment, the cost of which averaged approximately R.0.25 per acre, gave good control of seedling infection by anthracnose.

**111. A Preliminary Study on the Selection and Culture of Antagonists for some Cotton Disease Organisms with Reference to their Field Performance.** S. Y. Yin *et al.* (*Acta. Phytopath. Sinica*, 1, 1, 1955, p. 101. In Chinese. Abstract from English summary from *Rev. App. Myc.*, 37, 1, 1958, p. 43.) Of the 1,205 actinomycetes isolated during 1950-54 in various parts of China, 42.7 per cent. were antagonistic to *Verticillium albo-atrum*, 35.45 per cent. to *Fusarium vasinfectum*, 25.2 per cent. to *Rhizoctonia (Corticium) solani*, and 33.2 per cent. to *Pythium* spp., all infecting cotton.

The slowly sporulating isolates were generally the most active and those antagonistic to *C. solani* were usually highly antagonistic to the other fungi.

In the preparation of cultures for large-scale field application, cottonseed cake mixed with soil (1 : 4 to 1 : 8) was the best substrate, with 2.5 per cent. inoculum growth being best at 24° C., 21 per cent. R.H. and pH 6.5 to 8.5. In the field this preparation reduced seedling root rot and *Verticillium* wilt and increased yield.

**112. Studies on the Control of the Diseases of Cotton Seedlings.** S. Y. Yin *et al.* (*Acta. Phytopath. Sinica*, 1, 1, 1955, p. 115. In Chinese. Abs. from English summary from *Rev. App. Myc.*, 37, 1, 1958, p. 43.) Recent studies in China showed that the hot-water treatment of cotton seeds results in both disinfection and selection, immature seeds or those of low viability being less resistant. Treatment of mature seed at 55°-65° C. for 30 minutes reduced seedling infection (unspecified) from 68 to 0.9 per cent. without impairing germination, at 50°-55° the number of diseased seedlings was reduced to 33.25 per cent. and germination of immature seed was fair. Dusting with 0.8 per cent. ceresan or 3 per cent. zinc oxide or with antibiotic preparations after the heat treatment improved control.

**113. Host-Parasite Relationships of the Lance Nematode in Cotton.** L. R. Krusberg and J. N. Sasser. (*Phytopath.*, 46, 1956, p. 505. From *Pla. Dis. Rept., Supplmt.* 248, 1957, p. 133.) Host-parasite relationships of the lance nematode (*Hoplolaimus coronatus*) in cotton roots were investigated. Under low moisture conditions cotton plants in the field were severely stunted, yellowed, and almost completely defoliated in heavily infested areas. Populations of the nematode increased on cotton in the greenhouse, with little stunting of the plants. Seed germination was not affected by the nematode. In the absence of a host plant the nematode did not reproduce, and it is concluded that the nematode cannot live as a saprophyte.

**114. Effect of some Fungicides on Seedling Diseases of Cotton in the Irrigated Desert Valleys of Southern California.** D. C. Erwin *et al.* (*Pla. Dis. Rept.*, 41, 4, 1957, p. 324.) In experiments at the University of California in co-operation with the U.S. Department of Agriculture, *Rhizoctonia (Corticium) solani*, alone in 1954 and together with *Pythium* sp. in 1956, was incorporated in the soil before planting cotton seedlings. PCNB alone proved as effective in controlling *C. solani*

as when combined with other fungicides: zineb proved nearly as good in 1956, but not in 1954. Various factors of disease distribution and high salt concentrations complicated the tests, and *Pythium* sp. did not prove pathogenic.

**115. Effect of the Rhizospheric Microflora on the Growth of Cotton Plants.** M. S. Naim and A. M. Hussein. (*Sci. Bull. A' in Shams Univ., Cairo*, 1, 1956, p. 77. From *Rev. App. Myc.*, 36, 12, 1957, p. 761.) In experiments on cotton wilt (*Fusarium oxysporum*) at A' in Shams University, Cairo, three organisms (*Bacillus subtilis*, *B. licheniformis* and *Aspergillus terreus*) from the rhizosphere of cotton were found to stimulate the growth of cotton seedlings of the varieties Giza 26, Karnak and Ashmouni when inoculated into sterilized soil.

**116. Rhizoctonia Disease of Cotton in Presence or Absence of the Cotton Root-Knot Nematode in Arizona.** H. W. Reynolds and R. G. Hanson. (*Phytopathology*, 47, 5, 1957, p. 256. From *Rev. App. Myc.*, 36, 11, 1957, p. 697.) Investigations at Sacaton, Arizona, from 1952 to 1954 showed that nematode damage and mechanical injury to cotton seedlings increased their liability to infection by *Rhizoctonia (Corticium) solani*. In pot experiments, using 3,000 ml. of water per pot as inoculum, or 2,000 viable larvæ of *Meloidogyne incognita acrita*, or both, in steamed virgin soil, 64.7 per cent. of the Acala 44 cotton plants were infected after five weeks when both were present, compared with 48.2 for *C. solani* alone, 35.8 for nematodes alone, and 31.5 in the uninoculated.

In field tests fumigation with bromofume (3 gal. per acre) or dowfume W-40 (10 gal.) markedly reduced the extent of root-knot and therewith the amount of *C. solani* damage. Early invasion of seedlings by the nematode weakens the plants and increases loss by the fungus.

Artificial weakening of cotton seedlings mechanically by removal of portions of the cotyledons also increased the incidence of *Corticium* damage.

**117. Seedling Disease caused by *Rhizoctonia solani*.** H. W. Reynolds et al. (*Phytopath.*, 47, 1957, p. 256. From *Pla. Dis. Repr., Supplmt.* 248, 1957, p. 133.) Field surveys to determine the cause of a cotton seedling disease in Arizona indicated that the presence of the cotton root-knot nematode, *Meloidogyne incognita acrita*, affects the incidence of post-emergence damping-off of cotton, primarily caused by the fungus *R. solani*. Field surveys and experiments showed that an increase in *Rhizoctonia* disease was associated with an increase in the incidence of root-knot nematodes.

**118. Laboratory and Greenhouse Screening of various Fungicides for the Control of *Rhizoctonia* Damping-off of Cotton Seedlings.** J. B. Sinclair. (*Pla. Dis. Repr.*, 51, 12, 1957, p. 1045.)

Seventeen fungicides, alone or in combination, were screened in the laboratory and greenhouse to test their ability to control *Rhizoctonia solani* Keuhn, the principal causal organism of damping-off of cotton seedlings.

All the fungicides tested gave either complete or partial inhibition of the organism and a few were erratic in their action. There was a marked tendency for increased inhibition of growth as the concentration of the fungicides was increased.

The single chemical treatments that exhibited the most promising control were the omadine derivatives, PCNB, captan and nabam. Combination treatments showing the most promise were captan in

combination with PCNB, and the zinc salt of omadine; nabam in combination with zinc sulphate and mylone, and mylone plus PCNB.

**119. Development of Wilt Infection in Cotton in Relation to Nematode Populations.** W. L. Martin *et al.* *Phytopath.*, **46**, 1956, p. 285. From *Pla. Dis. Rept., Supplement* **248**, 1957, p. 133.) In Louisiana development of the wilt *Fusarium oxysporum* f. *casinifectum* was studied in cotton growing in steam-sterilized soil artificially infested with populations of nematodes alone, with the fungus alone, and with combinations of nematodes and *Fusarium*. Pure populations of *Meloidogyne incognita*, *M. incognita acrita*, *Trichodorus* sp., *Tylenchorhynchus* sp. and *Helicotylenchus* sp. were used. The nematodes reproduced abundantly on the cotton varieties Deltapine 15 (wilt-susceptible) and Coker 100 Wilt (wilt-resistant). Of the five nematodes used in the tests, only *Meloidogyne incognita* and *M. incognita acrita* significantly increased incidence of wilt in the two varieties. Severe injury to the cotton was recorded as a result of infestations of *Meloidogyne* only. Little or no injury was caused by the other three genera.

**120. Growth Responses of *Fusarium oxysporum* to Metabolites of some Rhizospheric Microflora of Egyptian Cotton Varieties.** M. S. Naim and A. M. Hussein (*Nature*, 22/2/1958, p. 578.) During studies on the rhizospheric microflora of different cotton varieties grown in Egypt, rhizospheres of *Fusarium* wilt-resistant Ashmouni proved to be inhabited by the highest percentage of strains of *Bacillus subtilis*, while those of wilt-susceptible Giza 26 contained the highest percentage of a strain of *B. megatherium*.

Preliminary screening tests in which each of the bacterial strains was streaked against *Fusarium oxysporum* on either Box's or soil-extract agar media have proved that *B. subtilis* strains were highly antagonistic to the wilt-inducing pathogen, while *B. megatherium* was stimulatory to *Fusarium* mycelial growth.

Further work concerning the nature of the inhibitory anti-fungal metabolites of *B. subtilis* and the stimulatory factor of *B. megatherium* for *Fusarium* growth is being carried out. It is thought that the former may be of the nature of an antibiotic, and the latter a growth factor, and that the differences observed between the rhizosphere microflora of wilt-resistant and susceptible cotton varieties might show why *Fusarium oxysporum* fails to invade Ashmouni cotton roots while its pathogenicity is established on susceptible Karnak and Giza 26 cotton varieties.

#### GENERAL BOTANY, BREEDING, ETC.

**121. New Breeding Technique for Producing Hybrid Cottons.** (*Uganda Cott. Assn. News Letter*, 15/1/1958.) In a report issued by the United States Department of Agriculture it is stated that a new technique for breeding hybrid cottons has been developed which offers a practical means for large-scale production.

In recent field trials, certain chemicals known as "selective gametocides" have been found to prevent pollen from developing in some varieties of cotton, with the result that the plant so treated cannot fertilize itself. If another variety is planted nearby that is unaffected by the chemical spray or untreated, it can provide pollen to fertilize the male sterile plants, and a hybrid offspring can be obtained.

While it is recognized that plant breeders have produced many excellent hybrids with outstanding yield and quality characteristics,

such crosses are usually obtained by hand-pollination in carefully controlled greenhouse experiments. The problem has been to find a practical way to produce hybrids in the field.

Field trials were undertaken with four green-leaved varieties planted in 40-foot rows between alternating rows of a red-leaved cotton, and considerable success in obtaining potentially useful hybrids was obtained.

**122. The Development of Cotton Hybrids under Different Light Conditions.** A. Pudovkina. (*Hlopkorodstvo Cott.-raising*, **6**, 1957, p. 33. From *Pla. Bree. Abs.*, **28**, 1, 1958, p. 118.)

After  $F_1$  plants of certain hybrids had been grown under short day conditions, the  $F_2$ ,  $F_3$  and  $F_4$  matured early, even when grown under conditions of natural daylight at Tashkent. When the  $F_1$  hybrids were grown under long day conditions, however, later generations matured late. The progeny from the  $F_1$  subjected to short day conditions showed improvements in yield and ginning percentages, but a decrease of 0.5 to 0.7 g. in boll weight.

**123. Duplicate Linkage Groups in Cotton.** C. L. Rhyne. (*J. Hered.*, **48**, 1957, p. 59. From *Pla. Bree. Abs.*, **28**, 1, 1958, p. 119.) Loci  $Yg_1$  and  $Du$  have been found to be linked with  $R_1$  in genome D of *Gossypium hirsutum*. On the basis of suggestions made by the author and other investigators,  $R_1$ ,  $Cl_1$ ,  $Yg_1$  and  $Du$ , now known to constitute a linkage group in genome D, are regarded as duplicates of the linked loci  $R_2$ ,  $Cl_2$ ,  $Yg_2$  and  $Lc_1$ , respectively in genome A. Problems arising in three-point linkage tests involving either of these groups are discussed. (Cf. Abstract 121, Vol. 33, this Review).

**124. A Note on some X-Ray Induced Variations in Upland Cotton.** S. Sikka et al. (*Ind. J. Genetics.*, **16**, 1956, p. 144. From *Pla. Bree. Abs.*, **28**, 1, 1958, p. 119.) When seeds of the variety 320F were treated with X-rays, structural changes in the flowers and in the chromosomes occurred, and self-fertilization was not possible. Bolls were set when crosses using normal pollen were made.

**125. Vivotoxin and Uptake of Ions by Cotton Plants.** T. S. Sadashivan and L. Saraswathi-Devi. (*Curr. Sci.*, **26**, 3, 1957, p. 74. From *Rev. App. Myc.*, **36**, 11, 1957, p. 695.) At the University Botany Laboratory, Madras, a disturbance in ionic uptake was observed in cotton plants grown in soil inoculated with *Fusarium vasinfectum*. In a resistant variety the presence of the fungus caused only a slight reduction in the uptake of potassium, calcium and magnesium and practically no change in their ratios, manganese content remaining unaltered. In the susceptible variety (K2) the imbalance in uptake and accumulation of these elements was considerable despite the apparently healthy condition of some of the plants. There was a considerable rise in the amounts of magnesium and manganese in susceptible, apparently healthy plants, and in those with wilt the manganese level was higher than in the uninoculated controls. A marked reduction in potassium occurred in all the susceptible plants.

It is suggested that the strongly indicated loss in semi-permeability of the cells of apparently healthy susceptible plants may be due to the action of vivotoxins, but that the amount of toxin, for unknown reasons, is insufficient to produce visual symptoms.

**126. The Effect of Plant Hairiness of Cotton Strains on Boll Weevil Attack.** W. K. Wannamaker. (*J. Econ. Ent.*, **50**, 6, 1957, p. 418. From *Pla. Bree. Abs.*, **28**, 1, 1958, p. 122.) Field trials were made in North Carolina on a series of hairy Upland cottons including

$F_1$  hybrids between Pilrose and other hairy types with special reference to resistance to *Anthonomus grandis*. MU8 and Pilrose, which carry the major genes for hairiness,  $H_1$  and  $H_2$  respectively, were significantly more resistant to attack than the other types. Certain unknown intensifying genes seem to supplement the action of  $H_1$  and  $H_2$ . It is suggested that certain hair characteristics, such as distribution, density and length, influence the resistance to the boll weevil.

**127. Sources of Resistance of Cotton Strains to the Boll Weevil and their Possible Utilization.** S. G. Stephens. *J. Econ. Ent.*, **50**, 6, 1957, p. 415. From *Pla. Beev. Abs.*, **28**, 1, 1958, p. 122. In this review the preference of *Anthonomus grandis* for certain species is mentioned. Observations made on the Upland group of *Gossypium hirsutum* cottons are recorded. These show that red plant colour, which is determined by the dominant gene  $R_1$ , increased hairiness, controlled by two dominant genes,  $H_1$  and  $H_2$ , and absence of stem glands, a recessive character,  $gl$ , render cotton less attractive to boll weevils.

**128. Long-Time Storage of Cottonseed.** D. M. Simpson. *Agron. J.*, **49**, 11, 1957, p. 608. Germination tests showed that the safe storage of dry cottonseed without special control of temperature is limited to somewhat less than fifteen years. In cool storage ( $70^{\circ}$  F. or below) very dry seeds may remain highly viable for twenty-five or more years with progressively greater life expectancy at lower temperatures.

#### FIBRES, YARNS AND SPINNING

**129. Equation for Predicting Single-Strand Yarn Strength and Elongation based on Measures of Raw Cotton Quality.** R. W. Webb. (*U.S.D.A. Mktg. Res. Rep.* No. 197, September 1957.) This is the first report in a series of relationship studies on cotton fibre properties which deals with single-strand yarn strength. All previous studies of this series dealing with yarn strength have involved the measure of skein strength. Thirteen equations are given, based on various measures of raw cotton quality, for predicting single-strand strength and elongation of any size of carded yarn within a relatively wide range.

**130. Rapid Method of Preparing Fibre Sections for Microscopical Examination.** F. Frunello. *Tinctoria*, **57**, 7, 1957, p. 276. From *B.C.I.R.A. Summ. Curr. Lit.*, **37**, 22, 1957, p. 729. The method described consists in the inclusion of the fibre tuft to be examined in a sufficiently rigid metallic support preventing the fibres from bending during cutting and enabling sections perpendicular to the fibre axis to be obtained. The support, which can be used repeatedly, consists of a simple brass foil (0.5 mm. thick) with a hole in the centre; a nylon-threaded needle is passed through the hole and returned, to form a loop by means of which the fibre wick to be examined (with the same thickness as the hole diameter) is drawn into the hole of the foil. The fibres are then cut on both sides of the foil, giving a minute section enclosed in the brass foil for microscopical examination.

**131. Electronic Fibre-Fineness Indicator.** *Text. World*, **107**, 8, 1957, p. 119. From *B.C.I.R.A. Summ. Curr. Lit.*, **37**, 24, 1957, p. 181. A new electronic fibre-fineness indicator is reported. A group of several thousand parallel fibres is laid on a slide which is then placed in the machine. The fibres are automatically scanned by a beam of light, one fibre at a time; after 1,000 fibres have been scanned the machine stops and a value of the average fibre diameter of the 1,000 fibres is given. The instrument has been developed for measurements on wool fibres.

## TRADE, PRICES, NEW USES, ETC.

**132. International Cotton Statistics.** (Int. Fed. Cott. and Allied Text. Indus., February 1958.) According to returns (now including those from the Soviet Union received at the Secretariat of the International Cotton Federation for the 1957 spindle and consumption census from the cotton spinning mills of the world, the total number of spindles in place on July 31, 1957, was 129,422,000 against a revised figure of 128,871,000 on the same date in 1956, showing a net increase of 551,000. As before, decreases took place in Europe and North America.

The world's cotton mill consumption for the crop year ended July 31, 1957, on the basis of spinners' replies, is estimated to be 42,438,000 running bales of all kinds. The following table shows this consumption by the various growths with the previous year's figures for comparison:

<i>Growth</i>	<i>Twelve months ended</i>		
	<i>July 31, 1956</i>	<i>July 31, 1957</i>	
American .. .. ..	11,552,000	14,394,000	
Indian and Pakistan .. .. ..	6,788,000	6,645,000	
Egyptian .. .. ..	1,253,000	1,058,000	
Sundry outside growths .. .. ..	19,344,000	20,341,000	
		38,937,000	42,438,000

The consumption figure is again a record arising not only from the increase in spindles but also from the increased average production per spindle due to the greater number of hours run in the coarser yarn mills. Consumption per thousand spindles has been steadily increasing since 1950 with increased shift working. Consumption of American cotton this year shows a considerable increase over immediate past years due to the present policy of the United States Government.

**133. Per Caput Fibre Consumption Levels.** (F.A.O. *Monthly Bull. Agric. Econ. and Stat.*, 6, 12, 1957, p. 1.) World consumption of "apparel fibres" is increasing more rapidly than world population. Whereas population growth is at a rate of 1.5 per cent. per annum, the total volume of apparel fibres manufactured in 1956 was 4.4 per cent. larger than in 1955, and a similar rate of expansion was probably achieved in 1957. Increases in fibre consumption have exceeded population growth most notably in Asia and Africa, where the *per caput* level, though still below one half of the world average, has advanced more steadily and rapidly year by year than in other regions.

*Per caput* consumption levels of fibres reflect not only contemporary economic requirements (some extending beyond the apparel field to those of carpets, automobile tire fabrics, etc.) but also the influence of climatic and social environments. There are, therefore, within regions noteworthy differences between countries of a broadly similar character which may be largely attributable to economic, cultural and political factors. In Europe, for example, the level in Austria is about 25 per cent. below that in Switzerland; in Latin America, the level in Haiti is nearly 50 per cent. below that in Cuba; in Asia, the level in Indonesia is much less than half that in Malaya; and in Africa the level in Liberia is about one-third that in Ghana.

Climatic considerations also contribute to the differences between inter-fibre patterns. Because of its general purpose character, cotton predominates almost everywhere. As regards apparel, however, it

might be expected that cotton would show greater predominance in areas of high temperature, and wool in more temperate zones. Similarly it might be expected that the lower valued cotton and rayon fibres would show relatively heavy utilization in regions with low  $p_{caput}$  consumption, and wool and synthetic fibres in high  $p_{caput}$  regions. It is notable that among under-developed regions the African continent consumes cotton and rayon together in the highest proportions, but, despite climatic conditions, has a lower proportion of cotton alone than other tropical regions. At the other extreme, the North American continent, notwithstanding its relatively high consumption level, consumes wool and synthetics together in smaller proportions than Western Europe, and, in spite of its temperate climate, the proportion of wool alone consumed is substantially smaller than in Western Europe.

*World Consumption of Cotton*

	Total (000's of metric tons)	Kilogram. per head
1950	6,960	2.78
1951	7,640	2.89
1952	7,370	2.94
1943	7,690	2.93
1954	7,930	2.98
1955	8,075	3.01
1956	8,320	3.05
1957	8,600	

*Examples of consumption per head in various territories, 1955-56*

	Kilo- grams		Kilo- grams
U.S.A.	11.5	Brazil	3.8
Canada	7.1	Egypt	3.2
Netherlands	6.2	Spain	3.0
Switzerland	6.1	Iire	2.5
Argentine	6.0	India	2.2
United Kingdom	5.9	Pakistan	2.0
Australia	5.9	Sudan	1.4
West Germany	5.3	China	1.2
France	5.2	Indonesia	1.1
U.S.S.R. and E. Europe	4.5	British E. Africa	1.0
Norway	4.4	Belgian Congo	1.0
Japan	4.0	Nigeria	0.7

## CURRENT NOTES

WITH deep regret we record the death from poliomyelitis of Mr. H. M. Parker on February 11, at Kaduna, Northern Nigeria. Mr. Parker joined the staff in 1955 after having held a Corporation studentship at Downing College, Cambridge, for one year. Before taking up his appointment in Nigeria, he spent three months at the Namulunge Research Station in Uganda and also stayed for a short while in the Sudan.

We regret to report also that Mr. P. A. Bowmaker, O.B.E., Director of Agriculture, Basutoland, who was a member of the Corporation's staff in South Africa from 1927-45, died in Bloemfontein Hospital on February 3.

The Corporation record with pleasure the awards of the C.M.G. to Mr. J. H. A. Watson and the C.B.E. to Mr. R. H. Pearce, both of whom are members of the Administrative Council.

Mr. E. O. Pearson has been appointed to succeed Dr. W. J. Hall as Director of the Commonwealth Institute of Entomology in June, and Mr. F. C. Bawden will become Director of Rothamsted Experimental Station on the retirement of Sir William Ogg in September. Both Mr. Pearson and Mr. Bawden are members of the Corporation's Panel of Scientific Consultants.

Dr. O. V. S. Heath, who was a member of the Corporation's staff at Barberton from 1927-1936, has been appointed Professor of Horticulture at Reading University.

Mr. A. N. Prentice of the Namulunge Research Station, Uganda, has resigned in order to become Deputy to the Chief Research Officer in the Department of Agriculture, Northern Rhodesia. Mr. Prentice joined the Corporation's staff in 1929, and we wish him every success in his new appointment.

Mr. H. L. Manning, Mr. H. G. Farbrother and Mr. P. H. Le Mare of the Namulunge Station, and Mr. J. E. Peat of the Ukiriguru Research Centre, Tanganyika, attended conferences on agricultural meteorology, pasture research, soil fertility and agricultural machinery, held at Muguga, Kenya, by the East African Agriculture and Forestry Research Organization.

Mr. J. E. A. Ogborn (Aden) visited Namulunge from January 15 to February 5 to discuss soil problems.

Congratulations are extended to Mr. J. R. Spence, the Corporation's Cotton Officer in the West Indies, on the occasion of his marriage in Antigua to Miss L. Shoul in December last.

The following members of the staff plan to arrive in the United Kingdom on or about the dates shown:

Mr. H. E. King	Nigeria	April 8
Dr. J. E. Dale	Uganda	April 15
Mr. J. H. Davies	Uganda	April 25
Mr. J. R. Spence	West Indies	late April
J. E. A. Ogborn	Aden	May 6
Mr. J. H. Saunders	Sudan	May 18
Mr. B. J. S. Lee	Nigeria	late May
Mr. K. R. M. Anthony	Aden	June 3
Mr. M. H. Arnold	Tanganyika	early June

# THE EMPIRE COTTON GROWING REVIEW

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Vol. XXXV

JULY 1958

No. 3

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## "WHEN I COME BACK . . ."

T. R. RICHMOND, Ph.D.\*

"It's a pity you can't stay longer; we'd like to show you our experiments in detail. . . . If you would stay a few more days, we could see this new agricultural area. . . . You are leaving again, and we have not discussed half the things we wanted to talk about!" These are some of the comments I heard last fall on my visit to some of the cotton research stations in Africa, and being human, I was flattered. It was not long before I had developed a stock reply which went something like this: "I'll do this, and see that, and take in everything else I missed on this trip, *when I come back.*" Though spoken in a light vein, for of course I had no assurance of ever getting back to that part of the world again, the statement was not entirely facetious. It was an expression of appreciation for all the nice things that had been done for me as well as the hope that some time in the future I might have the pleasure of visiting Africa again.

Considering the distance covered, and the number of stations and offices which I visited within eleven weeks, not much time was spent in any one place. It had to be so since I was away from my regular duties at my own station, and finances, too, had a limiting effect. Of course, everyone understood the situation, many of my hosts having had similar experiences during their travels abroad. Even though I had to hold to the tight schedule that had been arranged and push on to the next place listed on the itinerary, the invitations to stay longer sent me away with a good feeling that comes from knowing that I would be welcome to come again.

It all began in the fall of 1956 when the Director of the French Institut de Recherches du Coton et des Textiles Exotiques (IRCT) in Paris invited Dr. Meta S. Brown, my colleague at the Texas Agricultural Experiment Station, and me to visit their cotton research stations in French West and French Equatorial Africa. Supported by the recommendation of the Agricultural Attaché and other officials in the American Embassy in Paris, the proposal received favourable consideration by the U.S. Department of State and travel grants were awarded us by the International Educational Exchange Service (IES) of that Department. As negotiations and arrangements progressed,

\* Agronomist, Cotton and Cordage Fiber Research Branch, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, co-operating with the Texas Agricultural Experiment Station, College Station, Texas.

invitations to visit certain of their experiment stations in Africa were issued by the Belgian Institut National pour l'Étude Agronomique du Congo, Beige INEAC, and by the British Colonial Office and Empire Cotton Growing Corporation (ECGC). The Agricultural Research Service, of which I am a member, joined with the Foreign Agricultural Service of the U.S. Department of Agriculture in sponsoring the trip and in bearing portions of the expense which were not provided for otherwise.

The State Department classified our project as a "scientific cultural mission." We had to take some good-natured ribbing from colleagues in this country and abroad because of this terminology. Nevertheless, allowing for "broad" interpretations of our personal attributes, I could not think of a shorter, more descriptive phrase. As scientists, our primary purpose was to observe cotton research and production methods and techniques at experiment stations and in cotton growing regions in tropical Africa and to exchange information and ideas with the various workers concerned. Our "cultural" responsibilities were described to us in this way by one of our officials: "They'll be trying to find out 'what makes you tick' and you, in turn, will want to see how they get along."

We left College Station, Texas, on September 29. On October 8 we reached the IRCT Station at Bouake in the Ivory Coast, having in the interim undergone a briefing session in Washington, D.C., conferred with the Director and other officials of IRCT in Paris and "touched base" at Dakar. After spending a week at Bouake, I left Dr. Brown and proceeded to Nigeria where I visited the Samaru Experiment Station and was given a tour of some of the native cotton fields in the Zaria and Kano districts. In the meantime, Dr. Brown had stayed on for an additional week at the Bouake Station and then visited the IRCT Station at Anie, Togo. I joined Dr. Brown in Lagos on October 18. Proceeding to French Equatorial Africa, we first contacted the IRCT headquarters at Bangui and then visited experiment stations at Bambari and Bebedjia. Leaving French Equatorial Africa on November 11, we flew to Leopoldville in the Belgian Congo and after an overnight stop, travelled on to the INEAC Station at Gandajika. From Gandajika we went to INEAC's main station at Yangambi, where we stayed three days. Then, after spending one day in Usumbura in Ruanda-Urundi, we flew to Entebbe, Uganda. We visited the Kawanda Experiment Station near Kampala and the Cotton Research Station at Namulonge. We were joined in Uganda by Horace G. Porter of the Foreign Agricultural Service, U.S. Department of Agriculture. At the end of our visit in Uganda, Dr. Brown flew to Athens for a short rest while Mr. Porter and I visited the Shambat and Wad Medani Stations in the Sudan. Following a prearranged plan, we met Dr. Brown in Rome on December 3, where we conferred with American Embassy and FAO officials. The three of us spent December 4 and 5 in conference with IRCT and Embassy officials in Paris. Dr. Brown and I conferred with INEAC and Embassy officials in Brussels on December 6 and 7 and joined Mr. Porter in London on the 8th for conferences with ECGC, Colonial Office and Embassy officials. Conferences and reports in Washington followed on December 12 and 13.

On December 14, after some forty take-offs and landings, we touched down for the last time at our home airport at College Station. We had travelled more than 25,000 miles in eleven weeks, most of it by air, without missing a key connection and without a serious mishap, the only anxious moment being on the flight between Entebbe and Khartum when the left outboard engine ran wild and had to be shut off.

Sponsored as it was by four foreign organizations and an equal number in this country, the details of planning, organizing and arranging the trip were compounded, but so were the interest, activity and information. Under the circumstances, it is remarkable that we were able to move from country to country and from one territory or colony to another on the date, set forth in the master itinerary. This itinerary included four once-a-week plane flights and we connected with all four of them. There were instances, of course, where segments of the schedule had to be revised on the spot. Thanks to our capable, well-informed hosts, as well as to the splendid co-operation of the people in our embassies and consulates along the route, these local rearrangements were carried out without a hitch.

Friends in tropical Africa who had told us that the fall of the year would be a good time to visit that area certainly gave us good advice. We were in the area at the pleasant "in-between" season. North of the equator, where we spent most of our time, the rains had stopped, or very nearly so, and the really hot, dry season had not yet set in. South of the equator the reverse was true. Of course, conditions varied from place to place. Had we not come from Texas where we are accustomed to hot weather, we might have complained of the midday heat, particularly in Northern Nigeria, the Chad area and the Sudan. But most of the time and in most places even a "tenderfoot" would have been quite comfortable. Regarding the wearing of headgear, there were two schools: (1) the cork helmet proponents and (2) the cloth hat or no-hat fellows. Dr. Brown compromised by buying a cloth hat with a light cork crown interliner, while I made do with my old brown felt. We were both greatly reassured on this sunstroke business one day at Yangambi when our hosts on one occasion took us for an early afternoon spin on the Congo in their speedboat. Both were bareheaded: Monsieur wore a light, short-sleeved sport shirt and Madam a chic, sleeveless sun dress.

Most of the Europeans living on the experiment stations would describe their location as remote. However, it was apparent that there were varying degrees of remoteness. Some stations were near railways or airports, while others could be reached only by automobile over fair to poor roads. All of the workers, regardless of the location of their stations, had a deep appreciation for the airplane. Passengers, mail and freight move back and forth to Europe in a few days, where weeks or months were required only a few years ago. Several station workers, still in their thirties, told us how they spent weeks and months getting from Europe to their stations when they first reported for duty in Africa. None of these younger men claimed to have travelled on foot or on horseback, as did a few of the old timers we met, but the steamships, railways, river boats and trucks they used were slow enough according to our informants.

Living in Texas as we do, we were accustomed to wide-open spaces and a flat or gently rolling terrain, but even so we were hardly conditioned for the vast areas of desert, savannah, bush and forest that we saw on this trip. Towns and cities are indeed few and far between. "Mother Africa" is an apt term: much of the area, with the exception of the eastern highlands, does give the appearance of being old and worn. The total land area of the region we passed through is considerably greater than that of the United States and there appeared to be millions of acres of idle or virgin land that could be put to cotton cultivation if and when there is a great enough need. In this respect the level soils of the Ruzizi valley in Ruanda-Urundi, the rolling lands of the "fertile crescent" in Uganda and the vast, table-top smooth soils of the famous Gezira in the Sudan were particularly impressive. Although the inherent soil resources in the other regions through which we travelled did not appear to be as good, the relatively high yields obtained from cotton grown on the experiment stations and demonstration farms in these regions tell an important story. The combination of improved varieties and proved cultural and management practices can largely overcome the effects of a fair to average soil. For example, it has been demonstrated in several regions that such a simple practice as planting at the proper date, as compared with the "normal" practice of most native farmers, can increase yields by 30 per cent. or more. Because of time and travel limitations, we did not get to see several important, or potentially important, cotton growing regions in tropical Africa. From reports given us by station workers and other officials, as well as first-hand information, cotton production is increasing in Upper Volta and the Niger Bend regions of French West Africa; the Zaria, Sokoto, Katsina and Bornu districts of Northern Nigeria, production in the latter being a new development; the Ubangi and the southern half of the Chad provinces (including a recent extension near Kayabi) in French Equatorial Africa; and the Kasa, Lomami and Maniem districts of the southern zone and the Ubangi, Bas-Uele and Nepoko districts in the Northern zone of the Belgian Congo. There also are several extensive areas suitable for cotton growing in Uganda and the Sudan in addition to the ones we visited. Coffee production has become so profitable in recent years that it is displacing cotton in some of the regions where the soils and climates are favourable; this trend was particularly noticeable in the Bouake region of the Ivory Coast and the "fertile crescent" of Uganda.

When the difficulties of transportation, communication and other problems that have a bearing on the establishment and operation of research stations in these more or less remote areas are considered, it is amazing to see what has been done. For the most part, the key experiment stations are strategically located in terms of the problems to be attacked and the region to be served. They are supported by a system of outlying farms and test sites which provide supplementary or supporting data on weather, crop yields, etc. The buildings are of substantial construction, well designed to provide for the various research activities to be undertaken, and the grounds are attractively laid out and maintained. The field plots are carefully designed and the experimental

material is well managed. In addition to his responsibility for the over-all development and management of research programme, "housekeeping" activities on the station, extension and public relations work and other off-station duties, it is apparent that the field station director in tropical Africa must have other special qualifications. He acts a combination "mother" and "confessor" to the station staff, and at times I suspect he has to be a sort of judge or even a dictator. At all of the stations we visited a conscious effort was made to provide a "home away from home." This, of course, is no easy task considering the various personal problems that inevitably arise in groups living in remote areas under conditions which make it necessary to associate much of the time with the same people professionally as well as socially. The directors of the stations we visited in Africa apparently have been chosen carefully, for they certainly impressed us with the efficiency with which the stations are run and the harmony and co-operative spirit of the station community.

In some quarters there were expressions of concern about the recruiting and holding of assistants or junior staff workers. However, the situation at the stations in Africa in this respect appeared to be so much better than ours in this country that we could not be very sympathetic. There usually were one or two young assistants in each major staff position; they all seemed to have good training and, with few exceptions, they appeared to be industrious and enthusiastic. The staff scientists at the stations are exceptionally well trained, usually having obtained their formal education in a European college or university. Most of the workers also have undergone a period of training at an experiment station or institution in a tropical location other than the one to which they are presently attached. The three countries involved have co-operated admirably in providing training and experience for new personnel and in exchanging seed stocks and other plant material. The French programme of cotton improvement in tropical Africa began somewhat later than that of the other two countries that have sought to establish cotton production as a major enterprise in the region, and several of the leading French workers have received training and other assistance at Belgian and British stations. Several of the workers whom we visited had spent varying periods of time in the United States. Two of them, Paul Kammacher of the IRCT Station at Bouake and Walter Wouters of the INEAC Station at Gandajika, had spent more than a year working with our cotton genetics and improvement group at College Station, Texas. These two old friends literally took charge of us in their respective territories and tried, with admirable success, to anticipate our every desire and need. In addition to showing us their own research projects, which had grown from studies they had started at College Station, they acted as our guides and interpreters while we were on tour. Along the route we also had the pleasure of meeting M. Delattre of INEAC and M. Lecomte of INEAC who had paid us short visits at College Station some years ago. And at last, at Namulonge we caught up with Les Manning, whom we had somehow never quite managed to meet when he was here in the States doing graduate work. Mr. Manning took the trouble to make the long plane trip from Northern Nigeria, where he had been attending a

conference, to Entebbe, via Johannesburg, in order to show us around his station.

In Europe we had the pleasure of visiting friends and colleagues in cotton research who had at one time or another visited us at College Station. These were: M. Jean Lhuillier, Director-General, IRCT, Paris; M. M. Lecomte, Research Administrator in INEAC, Brussels; Sir Joseph Hutchinson, formerly Director of the Cotton Research Station at Namulunge and now a professor at Cambridge University and member of the Scientific Advisory Committee of ECGC, London; Dr. R. A. Silow, formerly on the staff of ECGC in the West Indies and now in the Institutions and Services Branch of FAO, Rome.

Although our primary interest was in cotton research we welcomed the opportunity given us by our hosts to observe various commercial phases of cotton production, marketing and processing. We also were glad to see the research work that was being done on other crops. All of the effort is by no means being placed on such cash crops as peanuts and coffee. All the stations that deal with general agriculture had research projects on native food crops, and even some of the strictly cotton stations were doing a little local food crop work "on the side." There was a cattle herd at nearly every station we visited and, being a sort of frustrated cow hand, I never turned down a chance to see the livestock. In most instances the cattle were kept mainly to supply milk for the station families and manure for the compost pit. But at several stations, notably the Shika Farm near the Samaru Station in Northern Nigeria and the Gandajika Station in the Belgian Congo, there were extensive projects in cattle breeding and pasture management. Generally, Zebu bulls were being used to upgrade local stock.

Without exception, the old friends we met and the new friends we made at the experiment stations, marketing boards, ginning plants, oil mills and spinning and weaving mills went out of their way to help us. It is impossible to imagine a more wholehearted spirit of friendliness and co-operation. An atmosphere of informality prevailed and we could not have felt more "at home" if we had been visiting our own stations here in the States. I always will think of the trip as a series of interesting, informative and pleasant seminars and field tours.

Brief comments on my impressions of agricultural research and related enterprises in the regions visited in tropical Africa may be of interest to those who have not lived or travelled in the area:

**1. Breeding and Improvement.** With good reason, the breeding and improvement of adapted varieties has been, and continues to be, the major research enterprise at the cotton stations in tropical Africa. Breeding work at the main stations is supplemented by systems of outlying or district trials which "sample" the regions to be served. The high yielding varieties that have been developed give abundant evidence of significant progress. At most of the stations the genetic variability in the breeding stocks still appears to be sufficiently high to allow further increases in yield to be made through the application of modern breeding methods. Special attention is paid to fibre quality and to disease and insect resistance. The development of adapted varieties with a high

degree of resistance to the bacterial blight disease and to the jassid is especially noteworthy. In addition to the breeding work on Upland types (*Gossypium hirsutum*) at Bouake, an improvement programme on *G. barbadense* is under way which is designed to serve the relatively small commercial production of the short-stapled, coarse-fibred, Ishan-type cotton grown in the region. Breeding and seed multiplication of this type also is conducted at the Anie Station in Togo. At the Wad Medani Station, which serves the Gezira in the Sudan, the development of varieties of *barbadense* with premium quality fibre is the main breeding activity, but there is also some work on Upland types. With these exceptions the varieties in the area trace back to Allen, Triumph and similar American types which were obtained from the United States in the early days of cotton culture in Africa. However, practically all of the varieties currently being distributed to native farmers in the region now appear to be so distinctly differentiated genetically from their American prototypes that most biologists would characterize them as African rather than American Uplands. Since we have had a full and free exchange of seed stocks with the various cotton stations in Africa in recent years, we did not find, or expect to find, any new varieties that had not already been tested at College Station, but we did get a number of valuable ideas on breeding and testing methodology.

**2. Agronomic and Other Practices.** While well-bred seed stocks are prerequisite to all crop improvement programmes and pay especially high dividends in the "bush culture" system which is generally practised by the peasant farmers of tropical Africa who use little, if any, fertilizers or insecticides, plant breeders are the first to admit that good varieties cannot do the job alone. The relatively high yields of cotton obtained on experimental farms are made possible through the co-ordinated efforts of workers in several disciplines, including genetics and breeding, pathology, physiology and entomology, soil science and engineering. We learned a great deal from the experiments on fertilizers, mulches, cropping systems, seed treatment and insect control.

**3. Crop-Climate Investigations.** Special attention is given to climatological investigations in tropical Africa. All of the research centres, including the cotton stations, keep extensive weather records, and at three institutions or stations there are comprehensive research programmes on the effect of climate on plants and soils. They are (1) the Office for Overseas Scientific and Technical Research (Orstom) near Abidjan in the Ivory Coast, (2) the INEAC Research Centre at Yangambi and (3) the Cotton Research Station at Namulonge. The most modern measuring and recording instruments and methods are employed at these stations to obtain data on the various elements of climate such as the frequency, amount and intensity of rainfall; solar radiation and cloud effects; wind direction and velocity; air and soil temperatures under various conditions; evaporation and many others. In addition, a number of ingenious devices have been designed by local scientists to meet special research requirements that cannot be met adequately or economically by commercial instruments. At Namulonge, and more recently at Samaru, significant advances have been made in the practical

utilization of weather data to cotton production; reference is made particularly to the use of rainfall distribution records in determining optimum planting dates. After seeing all this interest and activity in crop-weather research in Africa and realizing how little we are doing in this particular field, we began to wonder if we have been "asleep at the switch" in this regard.

**4. Species and Interspecific Hybrids.** Basic cytogenetic research on cotton species and their hybrids is in progress at the Bouake, Gandajika and Shambat Stations. At these locations the plants are grown out of doors the year round and we were impressed by the thrifty condition of the material and the abundance of fruit forms. Dr. Brown, who is the senior cytologist in our programme at College Station, was particularly interested in developing closer contacts with the geneticists and cytologists at these stations, and while there we discussed ways and means of improving the existing system of exchanging materials and information. The administrators of all of the organizations favour such a move and steps are being taken in this direction.

**5. Native Production.** Although most of our time was spent on experiment stations, we had an opportunity to tour a number of cotton producing areas. These were described to us as being more or less representative of other cotton areas in the region. Practically all of the cotton is produced under a peasant or "bush" system of agriculture in which a plot of ground is cleared and planted to cotton and food crops for a period of four to eight years and then allowed to remain fallow (or go back to the bush) for a relatively long period of time which, according to our informants, may range from eight to twenty years, depending on economic conditions, soils and other considerations. A native farmer and his family usually grows 1-3 acres of cotton annually. Compared with cotton grown on experiment stations or in seed increase blocks under European management where modern production practices are employed, the yield of cotton in the farmers' fields is strikingly small. How to translate proved experiment station practices to practical use by native farmers is recognized by every agricultural leader in the region as being the most important and, at the same time, the most difficult problem in cotton production yet to be solved. In addition to traditional experiments in cultural practices, research designed to reduce, or eliminate, the long fallow period is in progress at most of the stations. In a few areas, limited progress in encouraging native farmers to adopt better production practices has been attained through demonstration farms. In these the individual plots of cotton are grouped in such a way that seedbed preparation and other cultural operations can be done with tractors and insecticides can be applied with ground machines or planes.

**6. Marketing, Ginning and Processing.** We did not attempt to study these operations as such, but we did have the pleasure of visits with a number of district agricultural officers, gin plant directors and marketing board representatives who drew on their wide knowledge in the fields of cotton production and marketing to give us all sorts of useful information. We learned that planting seed, the foundation stocks of which are produced on experiment stations, is furnished free to farmers by government seed

distributing agencies; cotton is bought in the seed at a predetermined price (depending on grade) at local markets by licensed purchasing agents, consolidated at major markets and moved to gins which also operate under licences. Following the ginning process the lint is baled and practically all of it is moved to ports for export. Most of the seed is also exported. A small percentage is crushed and processed locally and in certain areas where the distance to port is great, transportation facilities are poor and there are no other local sources of fuel, cottonseed is burned in the fire boxes of the boilers at ginning plants. Along our route there were four textile mills, one each at Dakar, Bouake, Leopoldville and Jinja. We visited the Gonfreville mill at Bouake which spins the Ishan (*coaisse barbadense* type) produced in limited quantity in the Ivory Coast and Togo. This mill specializes in producing yarns for native hand weavers but, in addition, it turns out some very attractive machine-loomed fabrics. Recently this mill began blending rayon with cotton in an effort to produce finer yarns, a practice which is causing plant breeders at the Bouake Station considerable concern.

In these concluding remarks I must admit that we did not spend quite all of our time on cotton and other agricultural pursuits. All along our route of travel, our hosts pointed out places and things of historical interest. With justifiable pride, they showed us new schools, hospitals and other public buildings. We visited missions, fish hatcheries and power plants. Nor was native life ignored. We especially enjoyed visiting the markets and villages. Wherever we went we were provided with the best of everything available. We could not come home with tales of roughing it in "Darkest Africa," for we seldom strayed far from the main roads and air routes. In the towns and cities we stopped at modern hotels and on the stations we were accommodated in comfortable guest houses or in the homes of one of the senior officers. Wherever we went we were invited to dinners, dances and other social occasions in homes, restaurants and clubs. On such occasions we had the pleasure of visits with the wives and children of the officers and staff. There was, of course, some shop talk, but more often we talked about those things that congenial folks like to discuss when they get together—home and community life, mutual friends, our children, politics, schools, sports and the like. The whole trip was a most pleasant experience and one I shall never forget.

After a visit to this country a few years ago, Sir Joseph Hutchinson, who was then Director of the Cotton Research Station at Namulunge, complained bitterly about not seeing a single cowboy in Texas. I, too, have a serious complaint; I travelled thousands of miles through some of the most famous big-game country in the world—and I didn't see a single wild animal larger than a monkey—but I'll see plenty *when I come back*.

## A NOTE ON ETHIOPIAN COTTONS

G. EDWARD NICHOLSON, M.Sc.

THIS preliminary note is based on a collection of cultivated cottons made during the author's travels in Ethiopia (including Eritrea and Ethiopian Somaliland) between 1952 and 1957. A roughly representative sample from different areas consisting of 36 of over 150 collections of seed cotton from field samples and single plants was grown and studied by Sir Joseph Hutchinson at the Cotton Research Station in Uganda. The collections were made entirely from small peasant-cultivated fields, gardens, house yards, and in some cases isolated single plants.

Of the 36 collections grown in Uganda, 20 were *Gossypium hirsutum* var. *punctatum*, 2 were *G. hirsutum* × *G. hirsutum* var. *punctatum*, 10 were *G. barbadense* and 4 were *G. herbaceum* var. *acerifolium*.

In addition, 15 collections also sown in Uganda unfortunately did not germinate. A further group of 12 collections selected for study in Uganda have not yet been grown. No wild cottons were found despite fairly extensive search, especially for *G. somalense* in Eritrea.

*G. hirsutum* var. *punctatum* occurs in practically all cotton growing areas. These areas mostly lie below 1,500 metres and are mainly inhabited by Moslem and pagan Galla, Sidama, Nilotic and Bantu peoples. The perennial *G. barbadense* is grown where irrigation is practised in both the lowlands and the highlands. In the latter areas some overlapping with *G. hirsutum* var. *punctatum* occurs, as in the upper Awash valley. The only Old World species represented is *G. herbaceum* var. *acerifolium* which is confined mainly to the south of Ethiopia and to Somalia. Although *G. arboreum* race *soudanense* occurs both in Somalia and in the Sudan it has not so far been reported from Ethiopia and is not represented in the collection. The barrier discussed by Knight separating *G. somalense* in the Sudan from *G. somalense* in Somalia appears to have operated also in later periods to separate *G. arboreum* race *soudanense* in the same manner. *G. herbaceum* var. *africanum* was not found in these collections. The specimens on which Watt and others based their report of its occurrence in Nubia and Ethiopia have since been reclassified by Hutchinson as *G. herbaceum* var. *acerifolium*.\* The collection as a whole is chiefly representative of the south, south-west, north-east and east of the country, being specially weak for the west and north-west (the Blue Nile and its tributaries, Lake Tana, Sitit river region), where the altitude limits cotton growing to few areas in isolated river valleys and protected places. Climatically, the south and south-west is different from other cotton areas in the rainfed zone, though it is still typical of the "steppe bunch grass,

\* In particular *G. abyssinicum*, reported by Watt as "met with in East Sudan and Abyssinia," has been reclassified by Hutchinson as being definitely *G. herbaceum* var. *acerifolium* and not *G. herbaceum* var. *africanum* as previously given. The same specimen was first ascribed by Watt in 1907 to *G. arboreum*. The locality of the specimen (Schimper, 691 dated 1839, cultivated) is given as Tigre province. In Somaliland *G. herbaceum* var. *acerifolium* was reported by Mattei as *G. obtusifolium* Roxb. var. *wightiana* Watt. Two other species found by Mattei in the collections of Professor Paoli and named by him *G. paolii* and *G. benadivense* were included by Hutchinson, Silow and Stephens in *G. somalense*.

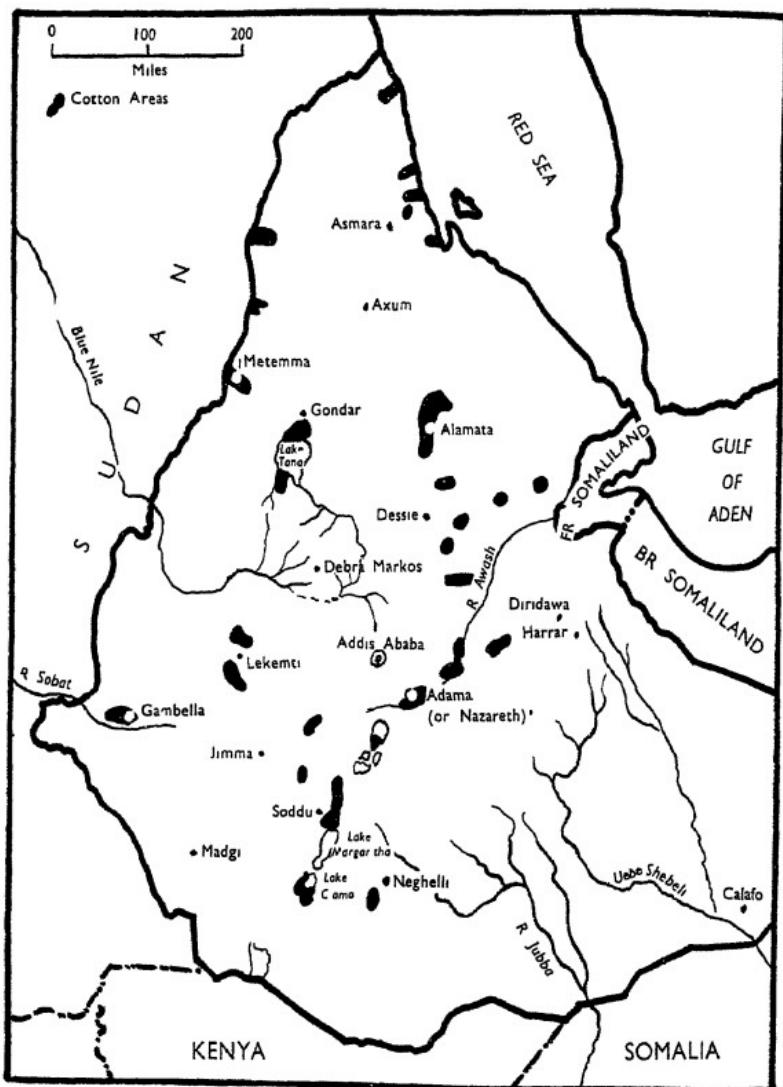
scattered short trees" regions where cotton is grown in Ethiopia. In the south-west the winter dry season is shorter than normal, while towards the south-east the rains fall in two distinct periods: March to May and October to November.

The literature on the cottons grown in Ethiopia except for modern introductions of cultivated Upland types is very limited. The dissemination of cultivated cottons in Africa has been discussed by several authors, especially Hutchinson, but detailed information from Ethiopia has generally been lacking. The "horn of Africa," including Ethiopia, is still physically and culturally somewhat isolated, and much work remains to be done in this region on plant exploration, agricultural geography, and the relationship of man to his crops. This part of Africa, as is well known, is extremely diverse in topography, climate and patterns of human migration and settlement. In many respects it is transitional between the Middle East, Asia and Negro Africa, possessing elements of all three from distant antiquity. Botanically, Vavilov placed one of his centres of variability of cultivated plants in this area, and more recently Sauer has also placed in Ethiopia one of the most important of his hearths of domestication and dispersal of seed plants which, he suggests, is linked with a subsidiary centre of vegetative planting on the Guinea Coast. Baccarini and Ciferri have discussed the complex relationships between Ethiopia-Somalia and Arabia with reference to the origin and dispersal of a number of cultivated plants.

Wild species of *Gossypium* are to be found in this region, though not those most closely related to the cultivated cottons. However, the manner in which the Old World cultivated cottons arose from the wild and the place where this occurred is still not precisely known. The hypothesis put forward by Hutchinson, Silow and Stephens in 1947 that the cultivated Old World cottons arose in the Indus valley from wild progenitors introduced from north-east Africa or Arabia has recently been rejected by Hutchinson, and an alternative area in southern Africa coinciding with the presence of *G. herbaceum* var. *africanum* suggested.

The earliest reference to cotton and Ethiopia known to the author is that contained in a well-known inscription found at Axum, the capital of the ancient kingdom of Axum, and still to this day the religious capital of Ethiopia. The inscription celebrates a successful raid in about A.D. 350 made by King Aezanas of Axum against the island of Meroe recently conquered by the Nuba. After the defeat of the Nubians on the Takkaze (Sitat) river, the inscription says, "My people took from them their corn, their minerals, their iron and bronze and they destroyed the idols contained in the houses and also their stores of corn and cotton and they threw them into the river Seda" (the Blue Nile). This inscription, although of special interest to present-day Sudan, also shows that the Axumites (and presumably also the Nubians) knew of the existence of cotton in Meroe and may have even cultivated it themselves. Unfortunately this is not at present known. Cotton cloth was certainly in use. Already in the first century A.D. cotton textile imports into Axum were important in normal trade. The *Periplus of the Erythrean Sea* gives a detailed account of the voyage to India along the Red Sea.

## ETHIOPIA . COTTON AREAS



coast and the Indian Ocean at a time when the main port of the Axumite kingdom was Adulis, and contains the earliest factual account of Ethiopia written by a European. Amongst many other items, imports into Axum, according to the Periplus, included "Indian cotton cloth; the broad cloth called monachè and that called sagmatogene" from Ariaca in the northwest of India and the Gulf of Cambay. Contacts between the Roman Empire and Meroe, Nubia and Axum were also established as early as the first century B.C. and continued to the fourteenth century A.D. Thus, an interesting account is given by Pliny who reports, as quoted by Forbes: "The upper part of Egypt lying in the direction of Arabia grows a bush which some people called cotton (*gossypion*) but more often by a Greek word meaning wood (*xylon*) hence the name *xyalina* given to Linens made from it. It is a small shrub and from it hangs a fruit resembling a bearded nut with an inner silky fibre from the down of which thread is spun. No kinds of thread are more brilliantly white or make smoother fabric than this. Garments made of it are very popular with the priests of Egypt."

The Meroitic cotton is presumed to have been the early stock of *G. arboreum* race *soudanense* as found in the Sudan today. This stock gave rise to the Meroitic industry in the Sudan, and also spread to West Africa. The existence today of a well-established spinning and weaving industry in Ethiopia, as is the case in the savannah country between the Sahara and West Africa, would call for the presence of an earlier cultivated cotton in Ethiopia than the present widespread *G. hisutum* var. *punctatum* on which this industry in Ethiopia is mainly based. However, if *G. arboreum* race *soudanense* was also introduced to Ethiopia in Axumite or other times—earlier or later—it has now probably disappeared entirely, since it is not represented in the present collection and, as already stated, no reference has been found to it in the literature. Hutchinson and Chiovenda mention its occurrence in the Uebe Shebeli and Jubba river valleys in Somaliland, and Glover and Rainey specifically in British Somaliland. Thus, this species is at present separated into two distinct areas (Somalia and the Sudan).

*G. herbaceum* var. *acerifolium* is believed to have been developed in Arabia. Owing perhaps to the presence of the already well-established *G. arboreum* race *soudanense*, it was not cultivated in the Sudan or Egypt, but it spread to West Africa, where it replaced *G. arboreum* race *soudanense* and "provided the new material for cotton spinning until it was supplanted by introductions from the New World" (Hutchinson 1947). If *G. arboreum* was cultivated in Ethiopia in the past, it is possible that *G. herbaceum* var. *acerifolium* replaced it in Ethiopia. However, it is also possible that *G. herbaceum* var. *acerifolium* was itself the first cotton introduced into Ethiopia. The presence together of *G. arboreum* race *soudanense* and *G. herbaceum* var. *acerifolium* in Somalia (the two species are found in the same territory in other regions where replacement has taken place), and of *G. herbaceum* var. *acerifolium* in southern Ethiopia only, would point to the first possibility. That is to say, the Asiatic cottons in addition to reaching Africa by the Red Sea route also reached Somalia from Arabia by the Indian Ocean trade route down the East African coast and must

have subsequently penetrated westwards into southern Ethiopia. More recently the New World cottons in turn have replaced the Asiatic species except in the limited southern areas (lakes Margarita-Ciamo and Somalia) where they are still found today together with *G. hirsutum* var. *punctatum*.

The characteristics of the two regions where *G. herbaceum* var. *acerifolium* now occurs are perhaps significant. In both regions the inhabitants form an isolated agricultural, linguistic and religious minority. In the Jubba and Uebe Shebeli valleys they are settled farmers of Bantu negroid stock, while on Lake Ciamo they are Nilotic pagan tribes linked with similar peoples to the West (Omo, Lake Rudolf) and down the Rift Valley. In both regions penetration and absorption by Moslem Somalis and Gallas, pagan and Moslem Sidama, and Christian Amahara has been resisted. The inhabitants of the Lake Ciamo region practise terracing and irrigation (specially in the Conso areas to the south) and they are probably the most skilful cotton spinners and weavers in the country. The Kushitic (Hamitic) Sidama groups occupy a large territory to the north and north-west towards the Omo valley (Wallamo, Gamo, Borodda), and the north-east (eastern Sidama). Huntingford has recently discussed the relationships between Sidama and Nilo-Hamitic peoples to the west and south-west in parts of what is now the Sudan and Uganda, and also the historical position of the Galla. Several authors have also discussed at various times the relationships of Sidama peoples and language to the northern Semitic groups. In general, it appears that the peoples of the river valleys of Somalia, the southern lake area and river valleys of Ethiopia, the western Nilo-Hamites, and some of the Ethiopian pagan Sidama groups, are the descendants of peoples who have occupied these regions since ancient times, certainly long before the first Galla and Somali migrations began early in the Christian era, and before the occupation of southern Ethiopia by colonizing Amaharas from the north. The Galla may have emigrated from south-western Arabia direct to the coast and valleys of present-day Somaliland, where they displaced the aboriginal negroids. As stated by Huntingford, it is clear at least "that the first African homeland of the Galla was what is now British Somaliland and northern Somalia, to which their own traditions bring them." Later (twelfth and thirteenth centuries) the Galla were themselves displaced by Somali migrations. They then began to move towards present-day Ethiopia and Kenya leaving scattered pockets of the original settled cultivators as isolated groups. Although large numbers of Galla, now mostly Moslem, have become settled farmers, they were essentially, and still are, a pastoral people, especially in the south (the Borana). They gained much of their agricultural knowledge from the Sidama, "including the use of heavy hoes in the production of root crops, *Ensete edule* (false banana), corn and grain sorghum, and perhaps—from Northern Sidama people—familiarity with the plow and the cultivation of teff, barley and wheat" (Brooke, 1957).

It is amongst these isolated groups in Ethiopia that *G. herbaceum* var. *acerifolium* is still cultivated, and where cotton growing and weaving is still especially important. The region extends eastwards and south-

eastwards from the old kingdoms of Kafa and Janjero and across the Omo river to the southern lake area. Amongst the people of the old Sidama kingdom of Janjero, for instance, the "cultivation of cotton is an honourable activity and weaving is not considered, as in other parts, an ignoble task" (A.O.I. Guida, 1938) (translation). Weaving is also the principal industry of the neighbouring Wallamo, Como, Borodda and Kullo peoples and it is important in Kafa. It seems likely, therefore, that *G. arboreum* may once have been grown in this region until its replacement—apparently complete now—by a subsequent introduction of *G. herbaceum* var. *acerifolium*. The Moslem Galla invasions between the twelfth and sixteenth centuries and the change in their way of life from nomadism to agriculture made them the instrument of the spread of many crops already cultivated in southern Ethiopia to other areas of the country.

This southern Ethiopian route of penetration from the coast, it may be added, would also appear to have been well established in very early times. Not only are the river valleys available as easy routes to the interior, but also the Chercher mountain range links the central and southern Ethiopian highlands with the east coast as far as Harrar and Jigiga, near the present-day border between British Somaliland and Ethiopia. The dispersal of other cultivated plants such as coffee, sorghum and *Eleusine*, widely grown in this region, may have taken place along this route. The links between the southern and northern routes in early as well as later times remain obscure. For instance, in a recent paper on *Ensete edule* by Smeds the author discusses Stiehler's hypothesis that *Ensete edule*, although now confined to the south, was in ancient times one of the basic plants in the economy of the negroid aboriginal population of Ethiopia: "This culture was spread over the whole plateau up to the Takkaze line, and it was taken over by the early Kushitic immigrants, but pushed back by the later Semitic immigrants from the north with their plough agriculture." Smeds rejects this hypothesis mainly on the grounds that *Ensete* has not lost its capacity for sexual reproduction, and that its cultivation must have begun in the south (where flour is prepared by a fermentation process) rather than in the north.

*G. hirsutum* var. *punctatum*, on reaching Ethiopia from the west at the time of its spread from West Africa to the Red Sea coast following the Moslem routes across the northern African savannah, was readily taken up by the settled cotton farmers of the country, many of them by this time themselves Moslem. It is now grown in Ethiopia in a wide variety of situations, and provides the present basis for the spinning and weaving industry. In all areas where Upland cottons have been introduced in recent times and are grown on a commercial scale, *G. hirsutum* var. *punctatum* × Upland hybrids commonly occur. Any future research and breeding programme for Ethiopia must take account of the wide adaptive variability in this species, and perhaps use it in the production of improved local varieties of cotton.

The possibility that *G. barbadense* existed in Ethiopia before 1820 has been put forward by Ware. Referring to Jumel's discovery of a perennial *G. barbadense* in Maho Bey's garden, Ware writes: "Jumel's plant which was observed in a garden mixture of cotton in Cairo, Egypt, in 1820 was

a perennial *vitifolium*. This stock had reached Abyssinia prior to the transfer of some seed for planting to the Egyptian garden." Alternatively *G. barbadense* may have been introduced to Ethiopia during the Egyptian occupation of Harrar Province between 1875 and 1885. From Harrar and Somalia *G. barbadense* appears to have penetrated into Ethiopia on the one hand along the northern foothills of the Chercher mountains and up the Awash valley, and on the other hand up the valleys of the Jubba and Uebe Shebeli rivers. The *G. barbadense* cotton of the southern lake area may have come from the direction of Neghelli, an area situated near the Genale and Daua rivers, both tributaries of the Jubba. Communication between Neghelli and west to the lake area in the Rift Valley across Borana is well established. This is the only cotton which peasants and traders in local markets in Ethiopia call "foreign," and it generally brings a higher price. The high regard that exists for the quality of the cotton yarn spun in these southern areas and Sidama is partly accounted for by the use of *G. barbadense* fibre.

#### Acknowledgments

The work of growing the collections was done entirely by Sir Joseph Hutchinson, until recently Director of the Cotton Research Station, Namulunge, Uganda, without whose generous assistance in this respect this task would have been impossible to accomplish. In addition, he kindly read the typescript of this paper and made several valuable comments and criticisms. The specimen from Ethiopia mentioned by Watt (Schimper 691) at the Cambridge Herbarium was kindly re-examined by Sir Joseph to check previous identifications.

Mr. A. J. Drewes, who was an associate of the Archaeological Section of the Institut éthiopien d'Études et de Recherches until 1957, read the typescript and made helpful suggestions in the course of extended discussions.

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Received April 1958.

## MAJOR G. S. CAMERON, O.B.E., M.C.

AS THIS issue goes to press, news has been received of the death in Salisbury, Southern Rhodesia, of Major G. S. Cameron. Born in 1890, he studied Agriculture at Edinburgh University and then worked on a tea estate in India until the outbreak of the 1914-18 war. During the war he served in Mesopotamia where he won the Military Cross, and he remained there afterwards, becoming Deputy Director of Agriculture in 1919.

He left Iraq to join the Corporation's service in 1924 as Cotton Specialist in Southern Rhodesia, and in 1936 became in addition Chairman of the newly constituted Cotton Research and Industry Board, which took over the Cotton Research Station, Gatooma, where the Corporation had maintained a research team since 1925. In 1939 this team had to be dispersed in order to help with food production in other territories, but Cameron remained in charge, for a time continuing as a member of the Corporation's staff, but later being seconded, and finally transferred, to Government service. In 1942 he was instrumental in the establishment of the Gatooma spinning mills, and in 1955, when the Board's responsibility for cotton growing research terminated, he continued as Chairman of the reconstituted Cotton Industries Board, which confined its attention to industrial activities.

# SOME OBSERVATIONS AND EXPERIMENTS ON ABYAN ROOT-ROT OF COTTON

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## Introduction

THE first recorded report of a root-rot or wilt of cotton in the Abyan scheme was by Pearson (1951) when he visited the cotton growing areas of the Aden Protectorate. In this report he described the symptoms of the disease, remarking that it occurred in definite patches often associated with a low point in the field. He noted that the general appearance was similar to a disease in Tokar, said to be caused by *Rhizoctonia bataticola* (= *Macrophomina phaseoli*), but the microsclerotia which should be visible on the surface of the wood of infected plants were not observed. Since that time the disease has been variously referred to, in the Aden Protectorate progress reports, as wilt (*Rhizoctonia*), wilt (*Rhizoctonia solani*), and wilt (*Rhizoctonia* and *Fusarium vasinfectum*). In December 1956 Dr. G. M. Wickens visited the affected areas of the Abyan scheme and recommended that the disease be known as "Abyan root-rot" to avoid confusion with other vascular wilt and root-rot diseases of cotton (Wickens, 1957).

Because of the reported increasing incidence of the disease and the fact that the causal organism has never been satisfactorily identified, arrangements were made for the writer to undertake on-the-spot investigations during October and November 1957, to attempt to establish the cause and the factors predisposing to the disease. This note sets on record the findings, impressions of the disease and suggestions for its further study.

## The Behaviour of the Disease

Root-rot was widespread in Abyan, its incidence varying according to the locality. The disease was appreciably more in evidence in the

TABLE 1.—COMPARISON OF MORTALITY BETWEEN  
SEASONS 1956-57 AND 1957-58 IN ONE FIELD.  
(Field 3. El Giar Farm.)

Strain	% Mortality Season	
	1956-57	1957-58
BAR XLI .. ..	17	52
Hybrids .. ..	8	34
Wilds Early .. ..	4	25

northern half of the delta, particularly on land which had grown cotton continuously since the beginning of the scheme, noticeably decreasing in incidence in the El Kod district. In the former area, near the village of

El Husn, infection on October 30 was estimated as high as 30-35 per cent. of the plant population. Unfortunately it was impossible, due to the activity of the dissidents, to revisit these northern areas after the disease had run its course, and furthermore there was no time available for a survey of the whole of Abyan in order to obtain an estimate of the influence of the disease on yield.

INCIDENCE OF ROOT-ROT SPREAD IN EXPERIMENT FIELD 8  
EL GIAR 1957-58



FIG. 1.

On El Giar experimental farm the disease appeared earlier and its incidence on BAR XLI, Wilds Early and their hybrids was higher in the 1957-58 season than in the previous season (Table 1). The first wilt symptoms in 1957 were observed on October 7 on 5-6-week-old plants. The number of wilted plants increased until the second week in November, but after this time there was a marked decrease in incidence, there being by the end of December virtually no further spread of the disease. This distinct periodicity is illustrated in Fig. 1, which represents the disease incidence in an area of 600 sq. metres (plant population approximately 1,800), in a field of X1730A. Plants were labelled as they wilted in order to map the progress of the disease. The map showed that infection began sporadically in the crop and from these foci extended in a roughly circular manner as the season advanced, frequently coalescing to form

large wilted areas. These areas were commonly 10-20 metres in diameter, but one in particular in the El Johl district extended over 5 acres.

The photographs in Plate I illustrate the rapid spread of the disease and the resultant havoc in a badly affected field on El Giar experimental farm.

### The Symptoms of the Disease

The disease is characterized by a sudden and complete wilting of the plant within a day, recovery being the exception. The leaves collapse, wither rapidly and remain attached to the plant. Another manifestation of root-rot, less common than the sudden wilting, is a more gradual wilting of the plant, beginning on the first day with a drooping of the lower main stem leaves which wither at the edges, followed by an upward infolding of the margins. This gradual wilt spreads upwards until at the end of the third or fourth day the whole plant is completely wilted. These manifestations are correlated with the extent of rotting of the root system.

These above-ground symptoms are identical with those caused by the Coleopterous stem borer (*Sphenoptera gossypii* Cotes) which was prevalent throughout Abyan, but not serious, during the first two weeks of October. With practice, a fairly safe determination of the cause of wilt can be made if the plants are observed on the first day of wilting—stem borer causes a complete wilt plus a drooping of the apex of the main stem, whereas with root-rot the plant wilts but the main stem remains erect. Otherwise, positive diagnosis can be made only by uprooting the plant and looking for the larva which tunnels in the wood, causing a swelling at the base of the stem.

Plants affected by root-rot can be easily pulled out of the ground, the main tap root usually breaking at a point about a foot below soil level. The symptoms in the roots are striking. The outer epidermis or cork layer is papery, tears easily and reveals below a shredded, spongy, bark tissue, usually stained brown, composed of separate fibres due to the decomposition of the parenchymatous cells of the inner and outer cortex. Within the shredded bark, and more so on the surface of the vascular cylinder, there is a deposit of a yellowish, granular substance of resinous nature. The central xylem tissue in recently killed plants is stained a vivid yellow colour which merges into a deep carmine colour at or about soil level, with carmine streaks extending from the edge of the rotted area upwards into the apparently "healthy" tissue. If the plants are left in the soil the yellow discolouration of the stem darkens to a brown or brown-black colour. The rot, even if plants are left in the soil, does not extend much more than 2 in. above soil level, where it terminates abruptly in a well-defined "high water mark," with carmine streaks extending as far as the cotyledonary node.

In plants that are infected but not wilted, and in plants recently wilted, the bark tissue is wet and spongy and, on squeezing, pale yellow drops of a sticky liquid can be expressed. In the majority of cases roots of infected plants emit a characteristic musty, rotten odour, reminiscent of a potato clamp.

Microscopic examinations made on roots to a depth of over 4 ft. below

PLATE I



*Above:* EL GIAR EXPERIMENTAL FARM—DISEASE INCIDENCE ON NOVEMBER 13, 1957.  
*Below:* EL GIAR EXPERIMENTAL FARM—DISEASE INCIDENCE ON DECEMBER 4, 1957.



soil level established, as suggested by Wickens (1957), that infection occurs deep in the soil and that wilting is a consequence of a rapid upward movement of decomposition in the cambium and parenchyma of the bark, to a point in the main tap root above the emergence of the topmost lateral root. The destruction of these parenchymatous tissues closely resembles that caused by a soft-rot organism. There is little plugging of the vessels of the stem. Crystalline deposits (possibly calcium oxalate) are abundant in the disintegrating parenchyma. The yellow granular substance, which appears to be resinous in nature, is probably produced by the plant as a response to the presence of the parasite.

In Abyan a disease similar to that on cotton was observed on lubia (*Dolichos lablab*), mung bean (*Phaseolus mungo*), pigeon pea (*Cajanus indicus*), velvet bean (*Mucuna* sp.), sesame (*Sesamum indicum*), castor-oil (*Ricinus communis*) and bamia (*Hibiscus esculentus*).

#### Other Reports of a Similar Cotton Root-rot

The symptoms and behaviour of Abyan root-rot are identical with those of a widespread and destructive root-rot of cotton in West Pakistan, first described by Butler (1918). He also described a similar disease on jute, groundnut, cowpea, mung bean, lubia, tomato, potato, brinjal, tobacco, lucerne and sesame. His attempts to reproduce the disease by inoculating large cotton plants with pure cultures of *Rhizoctonia* sp. failed. Vasudeva (1935), on the basis of results of inoculating cotton with fungi isolated from diseased roots, ascribed the disease to *Rhizoctonia solani* and *R. bataticola* (= *Macrophomina phaseoli*). However, later work by Khan (1954) failed to demonstrate the pathogenicity of these two fungi "under normal soil conditions." In the 1956 annual number of "Pakistan Cottons" it was stated that root-rot disease of cotton was widespread in the whole of the West Pakistan cotton belt and the identity of the causal organism had yet to be established.

A similar disease of cotton in the Tchad district of French Equatorial Africa was described by Saccas (1954) and attributed to a primitive fungus named by him *Olpidiaster gossypii*. His claim was based solely on microscopic observation of the fungus in diseased tissues and its isolation on a special medium. No infection experiments were attempted.

#### Infection Experiments

A number of fungi and bacteria were isolated on various agar media from the roots of wilted cotton plants. The fungi included the following species: *Macrophomina phaseoli*, *Petriella assymetrica*, *Didymella* sp., *Myrothecium roridum* and *Fusarium* sp., all of which have been recorded as being associated with diseases of the root and/or base of the stem. The bacteria included *Pseudomonas solanacearum* and several saprophytic soil bacteria. All these isolates plus macerated, infected roots were separately inoculated, by wounding, into the roots of healthy cotton plants. Three inoculation tests were made on 8-, 11- and 13-week-old plants respectively. No root-rot symptoms were induced in these infection experiments.

A likely explanation to account for the fact that no wilt occurred in these

trials (assuming that the real parasite was included in the isolates tested) is that the plants available were rather mature and had already developed resistance to the parasite. Again, it may be that some special conditions regulate the parasitism of the organism and were absent in these experiments.

Because of its catholic host range and the disease symptoms, perhaps the most likely pathogen amongst the isolates is *Pseudomonas solanacearum* (Brown Rot of the Solanaceæ and Slime Disease) (Dowson 1957). This bacterium attacks species of the Solanaceæ and plants of some thirty-two other families (Kelman, 1953). Among economic plants tobacco, potato, tomato and groundnut are attacked. Of the Malvaceæ *Hibiscus cannabinus* and *Urena lobata* have been recorded as susceptible hosts. Of the other crops grown in Abyssinia on which a similar root-rot was observed, velvet bean, mung bean, sesame and castor oil are recorded by Elliot (1951) as being susceptible to *Ps. solanacearum*.

At the time of writing Dr. W. J. Dowson of the Botany School, Cambridge, is carrying out infection experiments with the bacterium on the cotton varieties BAR XLI and Wilds Early and on lubia.

### Soil Sterilization

An experiment was designed by K. R. M. Anthony and J. E. A. Ogborn to investigate the effects of formalin and nitrogen on the incidence of root-rot in BAR XLI (susceptible) and Wilds Early (resistant) on a site on El Giar farm known from previous experience to be heavily infested with the disease. Formalin was applied at the rate of 250 ml. of 40 per cent. formaldehyde per square metre (which would cost over £40 per acre) and nitrogen at 5 gm. N as sulphate of ammonia per planting point (spacing 1 m.  $\times$  0.5 m.). Treatments and varieties were factorially combined in three replications. The plots (5  $\times$  3 sq. metres) were irrigated immediately after the application of formalin and planted fourteen days later on September 5, 1957. Soil moisture content in each plot was estimated by complete bores to a depth of 230 cm. four days after planting.

Records of the numbers of wilted plants in the middle row of each plot (each plot contained three rows) were taken from October 17 until the end of December at approximately ten-day intervals.

Analyses of the data indicated that:

1. The number of wilted plants in plots of Wilds Early was significantly less (at the 0.1 per cent. level) than the number in plots of BAR XLI. The overall mean percentage infection for Wilds Early and BAR XLI was 27.9 and 89.4 respectively, compared with 4 and 17 per cent. infection for these varieties grown in the same field in the previous year.

2. There appeared to be a positive relationship between the initial soil moisture content and the number of wilted plants in plots of Wilds Early, but not in plots of BAR XLI. Plot to plot variability in initial soil moisture was high.

3. At the beginning of the season, formalin was effective in reducing root-rot, but as the season advanced its effect diminished.

4. The effect of nitrogen was different from that of formalin. Although nitrogen had an initial visual effect on the growth of the plants there was no reflection of this at the beginning of the season by a reduction of root-rot. However, towards the end of the season there was less mortality in nitrogen treated plots than in those which did not receive nitrogen.

Valid statistical analyses of the factors involved in 2, 3 and 4 above have still to be conducted and depend on whether or not there was a significant relationship between the initial soil moisture content and the mortality rate in plots of Wilds Early. However, the results were in conformity with the following hypotheses:

1. That the resistance of Wilds Early was broken down in areas of high initial soil moisture.

2. That the primary pathogen can be destroyed by the application of formalin. In this experiment infection was delayed but not eliminated; either because formalin inactivated the pathogen in the upper soil horizons and the roots grew down into unsterilized soil, or because the plot size was small and the roots grew laterally into the untreated soil of adjacent plots.

3. That there is a close association between nitrogen and water use by the cotton plant. This has been demonstrated at Namulonge, where the soil in plots which had received nitrogen dried more rapidly and to a greater extent at 1 ft. than did the plots without nitrogen (Le Mare, 1957). If this relationship also holds in Abyan soils where there is but a single irrigation prior to planting, then it is conceivable that there was more rapid drying out in plots which received nitrogen, leading to less favourable conditions for the parasite and thus to less mortality in the nitrogen treated plots as the season advanced.

#### Factors Which May be Predisposing to the Disease

In an attempt to reproduce the disease and to investigate the predisposing factors, three experiments were set up using polythene bags to contain the soil (Logan and Coaker, 1957). The first constituted two watering treatments on contaminated and uncontaminated soil, with BAR XLI and lubia as susceptible hosts. The second trial contained the same soils, with macerated, infected root debris from the previous season placed in the soil in the middle of the bag, with or without formalin application (15 ml. of 40 per cent. formaldehyde in 250 ml. of water per bag), with BAR XLI as the susceptible host. In the third trial, soil underlying wilted patches at both El Kod and El Giar was removed from two horizons (0-3 ft. and 3-6 ft.) and treated either with freshly infected root debris or formalin, or both, with BAR XLI as the susceptible host. All three trials were of a factorial design.

Plant growth was good, but unfortunately no above-ground symptoms of wilt occurred whatsoever. This result further emphasizes the hypothesis that some special conditions were necessary for infection by the pathogen.

The most important predisposing factor to the disease is possibly the continuous growing of cotton on the same land since the beginning of the

scheme. The majority of the fields under cotton in season 1957-58 have grown cotton continuously for at least three years and a high percentage of these for six years. Acreage statistics, issued by the agricultural officers of the Department of Agriculture, indicate that in November 1957 96 per cent. of the irrigated land in Abyan was under cotton. Coupled with this is the fact that the cotton plants are not uprooted at the end of the season—the stems are merely cut off at soil level. These two factors may have led to a steady build-up of the inoculum potential of the parasite in the soil.

The literature on root diseases reveals that the soil conditions prevailing in Abyan favour root-rotting organisms. These conditions are the high alkalinity of the soil ( $\text{pH } 9 \text{ approx.}$ , strongly buffered by calcium carbonate) and the extremely high water-holding capacity of the light, silty, sand loam. Associated with the latter is the fact of a rising water table through over-watering the land, leading to increased salinity and alkalinity of the soil. Pearson (1951) reported that root-rot was often associated with a low point in the field. There is now no suggestion of this, possibly because of the water table, which is now generally high.

The present system of irrigation whereby water is fed from one field to the next is possibly a factor associated with the spread of the organism.

Results of a soil analysis to a depth of 230 cm. on November 24, 1957, by J. E. A. Ogborn, show no marked variation in soil texture, saturation percentage or salinity between adjacent wilted and non-wilted plots of cotton. Even although differences had occurred these would have been confounded with the effect of the bare patch caused by the disease, on the soil underlying the wilted areas. It is suggested that future soil analyses should be done before the wilt actually appears.

### **Recommendations for Further Experimentation**

#### *(1) Resistance Breeding*

Attention has been drawn to the fact that in the resistant variety Wilds Early, the level of attack can vary as a result of a number of factors of which inoculum potential, soil moisture and nitrogen status are the most important. Breeding for resistance must therefore be considered with great care.

(a) The present method on known infested land. There is evidence that by using the same piece of land over a number of years the inoculum potential of the parasite in the soil may be built up above the threshold value at which Wilds Early is resistant. This is the most probable explanation of why in field 3 on El Giar this variety succumbed to the disease in sporadic patches—one particular plot had 100 per cent. mortality. In three out of the four previous seasons this particular field was planted with cotton or cotton plus lubia to build up the inoculum potential for selection of resistant Wilds Early  $\times$  X1730A hybrids. To check the above hypothesis and to safeguard against further depletion of Wilds Early and hybrid stocks, it is suggested that two breeding trials be planted, one on land known to be heavily infested and the other (a duplicate of the first) on land lightly infested.

(b) Root inoculation with infected root debris. One reasonable hypothesis for the failure of infected root debris to reproduce the disease in the above-mentioned inoculation trials is that the plants build up high resistance to infection as they mature. It is suggested that these inoculations be repeated on 4-6-week-old plants of Wilds Early, X1730A and their hybrids.

#### (2) Seed Carry-over

It is possible that the organism may be able to infect the seed. This can be tested by replicating in single row plots seed taken from plants at the edge of a wilted patch with seed taken from plants on "clean" land, and planting the trial on "clean" land.

#### (3) Combined Soil Sterilization and Fertilizer Trials

Soil sterilization will possibly never be an economic proposition unless there is a residual effect over a number of years. As mentioned above, the effect of formalin was to delay but not eliminate the advent of the disease. In further experiments a larger plot size is recommended to cut out interference effects. Deeper placement of the sterilizing agent using a soil injector and various other soil sterilizing agents such as chloropicrin should be tried.

The effect of nitrogen in reducing the incidence of root-rot, its visible effect on growth, the increased yield from its application in fertilizer trials, and observations which suggest that a considerable area of Abyan would respond to nitrogen application, indicate that one of the factors predisposing to the disease may be the deficiency of this major nutrient in Abyan soils. In a fertilizer experiment on El Giar farm which was completely wiped out by root-rot, nitrogen was applied broadcast at the rate of 5 gm. N per square metre. This was half the rate at which it was applied in the soil sterilization experiment, where it was placed by the planting point. Further experimentation is necessary using high rates of nitrogen alone and/or in combination with soil sterilizing agents.

#### (4) Intercropping

Vasudeva (1941) showed that a remarkable reduction in the incidence of root-rot disease of cotton in the Punjab occurred when cotton was intercropped with any one of the following:

- Moth (*Phaseolus aconitifolius*)
- Cowpea (*Vigna catjang*)
- Guava (*Cyamopsis psoraloides*)
- Sorghum (*Sorghum vulgare*)
- Swank (*Panicum colonum*)
- Kangui (*Setaria italica*)

He found it necessary to adjust the time of uprooting the intercrop so that it did not markedly affect the yield of cotton. Moth gave the best results in reducing root-rot to a negligible percentage and by not reducing the yield of cotton. Vasudeva attributed the influence of intercropping on

disease incidence to lower soil and air temperature and higher humidity in the mixed crop compared with that in pure cotton.

None of the above listed crops has been recorded as susceptible to *Pseudomonas solanacearum*. Thus even if intercropping were not a success in Abyan, the three legumes might well be alternatives to the susceptible lubia, velvet bean, mung bean and pigeon pea which are grown at present.

#### (5) *Annual Survey of the Disease*

Surveys carried out yearly to determine accurately the distribution and destructiveness of the disease would give objective information on its economic importance both in the year of survey and potentially in the future.

#### (6) *Improved Agricultural Practice by the Cultivator*

No effective crop rotation has yet been established in the Abyan delta. The practice of growing cotton continuously on the same land has led to reduced vegetative growth of the plant, a decline in yield and, in conjunction with other factors, of grade. Furthermore it has led to the build-up of the inoculum potential of the parasite in the soil. If this becomes sufficiently high even the resistant Wilds Early succumbs, so that it may become the limiting factor to any other control measure. It is therefore of fundamental importance that the inoculum potential of the parasite in the soil be reduced. This can only be accomplished economically by adopting throughout the cotton growing areas of the Protectorate a sound agricultural system based on (1) an effective crop rotation, (2) a strict and thorough uprooting and burning of cotton plants at the end of the season, (3) a more controlled irrigation system to prevent overwatering, and (4) an alternative irrigation system to the present, to prevent the spread of the organism.

### **Summary**

Cotton growers in the West Aden Protectorate are faced with a highly destructive root-rot disease of cotton which has apparently increased in incidence since it was first reported in 1951.

Of the fungi and bacteria isolated from infected roots perhaps the most likely pathogen is the bacterium *Pseudomonas solanacearum*.

The factors predisposing the plants to the disease are not yet perfectly understood, but it is thought that the practice of continuous cotton growing on the same land is the source of the trouble. This practice, coupled with leaving infected root debris in the soil, has built up the inoculum potential of the parasite. Furthermore, it has led to a depletion of nitrogen in the soil resulting in poor plant growth, lower yield and grade. There is also a tendency to overwater the land which has raised the water table, thus increasing the salinity and alkalinity of the soil.

The breeding of resistant varieties, soil sterilization, added fertilizer, intercropping and improvements on the present agricultural practice are suggested as measures to control the disease.

**Acknowledgments**

I wish to thank Mr. K. R. M. Anthony and Mr. J. E. A. Ogborn, who kindly made available the results of the soil sterilization experiment and gave much other assistance. Thanks are also due to the Commonwealth Mycological Institute for identification of the fungi and Dr. W. J. Dowson for the determination of the bacteria.

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**APPENDIX**

- X1730A — Successor to X1730—an Egyptian L type.  
 BAR XLI — 1st filter of BAR 1730L—a selection from X1730A, resistant to leafcurl, to which the bacterial blight resistance gene  $B_2$  has been added.  
 Wilds Early — An American long staple, early maturing type.

*Received May 1958.*

# THE WEST AFRICAN COTTON RESEARCH CONFERENCE, NOVEMBER 18-23, 1957

## Introduction

J. H. GISBORNE

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Ministry of Agriculture, N. Nigeria*

THIS conference, held at Samaru, the Regional Research Headquarters of the Ministry of Agriculture, Northern Nigeria, was one of a series of informal West African specialist conferences arranged by co-operation between the French and British Governments. Previous conferences in the series were held on cacao at Tafo, Ghana, in 1953 and on groundnuts and millets at Bambe, Senegal, in 1954.

At these conferences representation has always been invited from West African territories other than British and French, and in the present case Ghana, the Belgian Congo and Portuguese West Africa were represented in addition to strong teams from the French and British West African territories. A very welcome innovation was the strong delegation from East Africa, consisting of Messrs. Manning and Farbrother from Namulunge and Mr. Arnold from Tanganyika. A cotton conference in Africa without representation from Namulunge would indeed have been a poor thing; it was with regret that it was learnt that, in view of his new duties, Sir Joseph Hutchinson would be unable to be present, as he had originally intended.

The conference was opened by the Hon. Mallam Mustafa, M.H.A., Minister of Agriculture in the Northern Nigerian Government, who, in welcoming the delegates, said that he was very conscious of the debt owed to European expertise in the rapid technical and economic development of Africa. He hoped that all the delegates regarded it as their sacred duty to train Africans in their own skills, and that when next there was a Cotton Research conference at Samaru there would be, in the words of Aggrey, "both black and white keys on the piano." The Minister then went on to outline the rapid growth of the cotton industry in Northern Nigeria since the end of the 1939-45 war, and paid tribute to the part played by the introduction of the Marketing Board system and to the plant breeders at Samaru for the great part they had played in this expansion.

In the general session which followed the Minister's speech, Mr. H. E. King presented the paper on cotton problems which is printed in this issue. Subsequent sessions covered agronomy, breeding and selection, entomology, pathology, legislation, grading and marketing and finally plant environment.

Outside these sessions, visits were made to the cotton breeding plots, the cotton laboratories and the soil moisture plots at Samaru, and to local peasant farmers' plots of cotton and the cotton ginnery in Zaria.

Discussion at the sessions was free and informal, and continued at a number of drinks and dinner parties in the evenings. It was a very fortunate circumstance that the most lively discussion of the conference, with no holds barred, came in the final business session on plant environment, as a return to duller subjects after this stimulating experience would have been very much of an anticlimax.

The staff of Samaru, on whom the duty of organizing the conference had fallen, were very appreciative of the friendly spirit of co-operation which they met from all delegates, and of the very kind expressions of appreciation of the conference and the arrangements which delegates made at the close. From our point of view it was a week of considerable anxiety, but the delegates made it a most enjoyable week also for all concerned.

I should like to point out that all the papers presented at the conference, including those printed below, will in due course be published in the Proceedings, though there may be some delay. When published, the Proceedings will be obtainable from the Librarian, Regional Research Station, Ministry of Agriculture, Samaru, Zaria, N. Nigeria. Finally it should be noted that, as far as papers from the Northern Region of Nigeria are concerned, any discussion of matters of policy and future development of the industry represents the view of the individual author, and is not necessarily the view of the Regional Government.

### Cotton Problems—A Brief Survey

H. E. KING

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The problems facing the cotton growing industries of the various African territories are numerous and diverse. Some are perhaps unique to a particular area, but many are common to several territories and some are universal.

Problems which are not identical can often be handled by similar methods: free discussion and exchange of information between delegates from various countries may therefore be found helpful over a wide field.

As a possible aid in such exchange a rough grouping of the more obvious problems may be attempted: broad groups may perhaps be recognized as follows:

Social and Economic  
Agricultural  
Botanical  
Entomological  
Technical

The boundaries between groups such as these must of necessity be somewhat vague; some problems cannot be made to fall clearly into any

one group, but these five headings may suffice as a framework to give form to a brief survey of some of the problems which must engage the attention of cotton workers.

### Social and Economic Problems

Under this heading fall such questions as "Why grow cotton?", "Is there a place for it in the economy of the country?", "Does the income from the cotton crop serve a sound social purpose?" and "Is it likely to remain of importance?". Until such questions have been asked and answered, expenditure on developing cotton growing cannot be justified. When answered, a comprehensive long term plan is required if the money is to be well spent. The organization of agricultural, botanical and technical research, the establishment of a seed supply system, ginneries and marketing arrangements, must not be put in hand lightly and halted abruptly. In consequence care must be taken to distinguish between short term requirements, resulting perhaps from trade and currency restriction of a temporary nature, and the long term true needs of the country.

The answers to these questions are controversial, but in the writer's opinion the desirability of retaining and developing cotton as one of the major crops of tropical Africa is beyond dispute. In spite of the phenomenal development of artificial fibres the demand for cotton continues to grow. Figures for the consumption per head of population in highly developed countries and contrasting figures for the, as yet, backward countries suggest an eventual *immense* increase in *world* demand.

Taking, however, a narrower view, Nigeria is a large and rapidly growing consumer of cotton goods; cotton growing fits well into the rural economy and provides much needed revenue. To produce therefore at least as much raw cotton as is needed to clothe its people seems only reasonable. To do this requires an immediate substantial increase in the crop. To meet the increasing demands of the future will require production to be stepped up very considerably indeed and justifies the maintenance of research and extension work regardless of current fluctuations in demand and price.

The long established popularity of cotton as a regular field crop over much of Northern Nigeria, and the success achieved over the past seven years in extending its popularity into new areas, suggest that the necessary further increase in production could be obtained without great difficulty by encouraging increased planting and maintaining the price. A drop in price, however, could well reduce the popularity of cotton growing at present yield levels.

To step up yields per acre and, more important still, per unit of labour devoted to the crop is therefore a sounder aim; by this both the size of the crop and the profit to the grower can be increased even in the face of lower prices. Moreover increased production obtained by this means would not involve a greater acreage and consequent fears that cotton was encroaching on land needed for grain crops. As a long term objective the production of twice the present crop of Northern Nigeria on a reduced acreage by means of higher yielding strains and more efficient cultivation

would appear both desirable and feasible. Proper attention to the timeliness of cultural operations alone could go a long way to achieving this; delayed planting is responsible above all else for the present low average yields.

One further point of economics, of particular relevance to this inter-territorial conference, is the influence of price stabilization measures on the movement of seed cotton across territorial boundaries. Almost throughout Nigeria cotton is a local trade commodity moving freely from place to place quite independently of the official marketing arrangements for the export crop. Such movement is not confined within the political frontiers and traffic over the borders, in one direction or the other according to demand, is held to be very considerable. Apart from vitiating production statistics such traffic can have adverse effects on the quality of the planting seed and the commercial export crop.

In fixing the price to be offered for seed cotton in localities near to inter-territorial boundaries, therefore, it may be necessary to consider what is being paid over the border.

### Agricultural Problems

The second group of problems, those coming broadly under the term "agricultural," is perhaps of more direct interest to this conference. Agricultural systems in relation to the nature of the soil, the climate and the crops to be grown provide scope for much study and present problems whose solution is essential before full advantage can be taken of plant breeding or pest and disease control measures.

Traditional patterns of African peasant agriculture with their low yields of almost all crops present a challenge to the agricultural scientist. Investigations into crop rotations and the use of resting periods under bush or fallow have long been pursued at many experimental stations, but with results which are often indefinite and difficult to interpret. The introduction of mixed farming with the production and use of farmyard manure has given promising results in a number of areas, but progress in establishing it on a really wide scale has often been most disappointingly slow.

The use of fertilizers promises very substantial increases in yield in some conditions, but here again results lack consistency and difficulties may arise in exploiting them in peasant farming.

It is now becoming increasingly clear that many of the problems of soil treatment and crop nutrition can only be solved by an approach which takes into account the limitations imposed by climatic factors and in particular rainfall distribution. The interplay of rainfall incidence, run-off and evapo-transpiration with planting date, plant population and leaf area must be studied in conjunction with soil type and fertility level.

The conference is fortunate in having Messrs. Manning and Farbrother from Namulunge here to take part in discussions on these matters, the importance of which extends beyond West Africa and the cotton crop.

The papers being presented on various aspects of agronomy and plant environment by delegates from the different territories bear witness to the importance attached to this group of problems.

**Botanical Problems**

Under this third main heading fall the problems inherent in the botanical characteristics of the genus *Gossypium*. Foremost amongst these the writer would place the intolerance of the cotton plant to competition whether from weeds or other crop plants or even other cotton plants.

The practice of mixed cropping in which several crops share the same piece of land is widespread and deeply implanted in indigenous agricultural systems of many parts of Africa. Nowhere, to the writer's knowledge, has a variety of cotton been developed which yields really satisfactorily under such conditions. Attempts to breed varieties able to compete better with weeds or to fruit well when interplanted with other crops have met with little success. Improved Ishan A, bred in the Western Region of Nigeria for growth intercropped with yams and other field crops, gives in general very low yields. The introduction of more aggressively strong growing perennial types is likely to raise more problems than it solves.

Other limitations of the cotton plant lie in the need for relatively high temperatures and ample sunshine. These requirements conflict with those of water supply where rain is the sole source of water; the highest yielding crops are those grown under almost uninterrupted sunshine in hot arid climates with moisture requirements met solely by irrigation. Where cotton is grown under high rainfall conditions the lack of sunshine may seriously delay fruiting and limit the final yield.

A characteristic of great importance in cotton is its indeterminate fruiting habit which enables it to continue to grow and form fruiting points through a long period in which conditions are not suitable for the setting and maturing of fruit. In consequence unsuitable conditions, such as the lack of sunshine mentioned above, or a heavy attack of insect pests, hail damage or periods of drought or floods, do not necessarily result in a complete failure of the crop. The continuation of growth following such an unfavourable period may enable a crop to be brought to maturity later. Instances are numerous in which plots suffering the complete loss of early fruit have recovered and given equal (or even higher) yields compared with plots escaping such damage. This characteristic, valuable as it is, greatly increases the difficulty of assessing the value of treatments which may be applied to the crop, including insect control measures. It also results, in Northern Nigeria, in wide fluctuations in time of arrival of the crop. With early July planting the bulk of the crop may be matured and picked before the end of December in one season: in another, boll opening hardly commences before January and continues into April.

There are of course wide varietal differences in earliness of cropping. Breeding work in the United States and in Egypt has been notably successful in producing early types. Under tropical African rain grown conditions, however, the older varieties with longer growing period and unimpaired ability to compensate for loss of early fruits have in general proved more suitable. This divergence in the characteristics of cultivated varieties bred for different conditions means that the exchange of material between for instance the United States and tropical Africa is of limited

value. The trend towards glabrous leaf (to reduce the clinging of leaf trash to the lint in picking) in the States further reduces the suitability of modern American varieties for those parts of Africa where a high degree of leaf hairiness still remains the best protection against crippling jassid damage.

Within the limitations referred to above the genus *Gossypium* is notable for the wide range of variability, both between and within species, available for exploitation by geneticists and plant breeders. Increasing use of this reservoir is being made in attempts to improve economic characters by gene transference between species, but for much of the plant breeding work in Africa reliance may still be placed on the notable degree of persistence of genetic variability within even quite highly bred material subjected to long continued selection.

Under this same broad heading of "botanical" can be mentioned the plant diseases, amongst which bacterial blight, *Xanthomonas malvacearum*, takes the most prominent place in most African territories. The complexity of the problems which this disease presents in its various forms and methods of survival are such that a whole conference might be devoted to this alone. There will be general agreement that the long term solution lies in the breeding of resistant varieties, although it has been suggested that, even when satisfactorily resistant strains have been developed, routine disinfection of planting seed should be continued as a precaution against the risk of this resistance being broken down by the appearance of a new race of the pathogen.

### Entomological Problems

Cotton is pre-eminent amongst tropical field crops in its susceptibility to attack by insect pests of such widely differing characteristics that control measures present innumerable difficulties. A solution arrived at in one country for the control of one pest may prove totally useless against a different insect in another territory. Even in this wide field, however, there are certain general considerations of universal applicability. Above all a control measure must produce a *profitable* increase in the crop. The crop and the conditions under which it is growing, apart from exposure to insect pest attack, must therefore be such that a profitable response is possible.

This is not at present the case with a great part of the peasant grown cotton crop of N. Nigeria. Until soil fertility and standards of cultivation have been raised substantially there can be no hope of an economic return from the use of expensive insecticides even in circumstances where effective control of some damaging insect has been demonstrated in experiments. Until this situation has been changed substantially, control measures are virtually limited to the destruction of plant debris at the end of the season and the enforcement of an effective close season, though the existence of alternative host plants reduces the effectiveness of this in some cases.

The contributions of the plant breeder to the solution of insect pest control problems are limited. Jassid resistance has been achieved and prolific fruiting plants with high powers of recovery from bollworm

damage have been developed. Direct resistance to bollworm attack and to stainers (*Dysdercus* spp.) has not yet appeared in cultivated varieties, but genetic differences in susceptibility to damage by Miridæ (*Lygus* and *Campylomma* spp.) have been demonstrated.

### Technical Problems

Under the broad heading of technical problems may be grouped problems of technique in breeding work, field experimentation, laboratory testing of lint quality, seed multiplication schemes, seed distribution problems and the organization of grading, ginning and marketing.

In many of these the requirements and special circumstances in different territories may result in the development of very different methods. There is however much common ground; certain difficulties inherent in the African environment are experienced almost everywhere. In testing progenies and varieties in replicated field experiments, for instance, plant to plant and plot to plot variation is frequently extreme. Techniques successfully employed in Europe fail in the face of disasters such as damage by hail, lightning, monkeys and elephants superimposed on fields in which gullies, rock outcrops, termite mounds and tree stumps preclude any semblance of uniformity.

Even where a high degree of replication, accompanied by a measure of luck, has given statistically significant differences in one experiment the seasonal variation in response is often so great that further results will be quite contradictory. Frequently therefore the experimenter must be content with less clear-cut results than would be acceptable in other circumstances and rely to a greater extent on personal judgment in spite of the inevitable pitfalls. The exchange of views on these matters can be helpful even if a wide measure of agreement cannot be reached. It is clear from the results being achieved in the various territories that quite different techniques can equally lead to success in breeding work.

Problems of measuring lint quality locally, both in breeding work and in the classification of the commercial crop before export, are far from complete solution. Difficulties lie in the definition of "quality" and in the attempt to strike a balance between accuracy of determination and number of samples which can be handled. Adequate sampling, having regard to the variations in quality resulting from environment, also presents great difficulty. Seasonal fluctuations in quality, as in yield, are very considerable and confusing both to the plant breeder and the commercial cotton marketing organization.

The technical requirements of seed multiplication and distribution schemes are simple, but their fulfilment in practice presents difficulties. Three papers to be presented at this conference illustrate how these may be overcome or circumvented.

Legislation, grading and marketing, which are also to be discussed at a later session, present some troublesome and complex problems in the face of changing economic and political conditions.

**Genetic Differences in Vitality of Cotton Plants  
Cut Back at the End of a Season**

H. E. KING AND B. J. S. LEE

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Amongst the problems of the cotton growing industry of Northern Nigeria is that of enforcing a close season. Left to themselves a large proportion of the plants in a cotton field will live through from one rainy season to the next. This is true not only of *punctatum* types (*G. hirsutum* var. *punctatum*) and Ishan (*G. barbadense*), but also of the apparently true *G. hirsutum* variety Samaru 26C.

Severing the main stem above ground level does not kill every plant; fields treated in this way can sometimes show several hundred sprouting stumps per acre two or three months later. Since more effective methods of destruction, such as uprooting bodily, are tedious (and indeed barely practicable commercially in Nigeria) a search for strains with a reduced tendency to survive cutting back seems worth while.

Unfortunately the variation from patch to patch in a field of the vitality of cut back stumps is immense—perhaps related to variations in soil texture, root penetration and moisture retention. Counts of sprouting stumps in a variety test after the end of season 1952-53 showed a plot to plot range from 1% to 21% within a single strain. Under such conditions even quite large varietal differences could escape detection.

At the end of last season, however, every plant in a large replicated progeny row test (49 progenies in eightfold replication) was cut back and the stumps kept under observation. The material in this test was all of Samaru 26C derivation, originating from the American Upland variety Allen's Long Staple, and had been selected for the usual economic characters only (yield, lint quality, jassid resistance, etc.).

A statistical analysis using the inverse sine transformation for percentages\* revealed differences between progeny means in the survival and sprouting of stumps which were highly significant. The extreme range was from 65 per cent. down to 10 per cent.—suggesting that this character might well respond to deliberate selection.

There was no correlation between strength of tendency to regrowth and the yields recorded before cutting back—viz., no suggestion that progenies which had been more fruitful had either more or less residual vegetative vigour than less fruitful progenies. The stumps, whether carrying vigorous fresh green shoots or apparently dead, were heavily infected by stem borer (*Sphenoptera* sp.), but again there was no correlation with percentage regrowth; the progeny differences in the latter were apparently not the result of differing susceptibility to stem borer.

Progenies with high and with low mean regrowth figures have been carried forward and further studies will be made. In the meantime it is thought that the existence of genetic differences in this character within the species *G. hirsutum* may be of interest to plant breeders elsewhere.

\* Cochran, W. G.: *Emp. J. Expt. Agric.*, 6, 22, April 1938.

## ADDENDUM

Since this note was written, the results of the 1957-58 replicated progeny row test have become available. This test contained groups of progenies grown from single plant selections made within twenty-one of the progenies of the 1956-57 test, including some which had differed widely in regrowth counts.

As in the previous test, all plants were cut back at the end of the season and the amount of regrowth recorded. Once again, highly significant differences appeared. Moreover, progenies of common derivation tended to behave similarly and, if derived from a parent type which had given a low count in 1956-57, the group mean tended to be low compared with the mean of a group derived from a progeny of high count. For the twenty-one groups the counts for the two seasons showed a highly significant positive correlation. The heritability of the character is thereby confirmed.

## COTTON IN THE U.S.S.R.\*

THE basic philosophy of the Supreme Presidium of the U.S.S.R. is to attain the same standard of living as the capitalist countries and eventually to surpass it.

In 1956, production in the U.S.S.R. reached 4·3 million tons of seed cotton, equivalent to 1,488,000 tons (6,860,000 bales) of raw cotton. (Production of fabrics was 5,452 million metres.) The U.S.S.R., therefore, is now second only to the United States as a cotton producer and, in fact, obtains an even better average yield for the country as a whole.

With the ultimate aim of catching up with the United States, the U.S.S.R. intends to raise production to 7 million tons of seed cotton (about 11 million bales) by 1966 and to 10 million tons (16 million bales) by 1970. These targets are considered to be sufficient to meet domestic requirements and supply the demand from Eastern Europe. To implement this programme, the area sown to cotton will be expanded from the present 5 million acres to more than 10 millions.

In order of importance the Republics interested in cotton production are as follows:

Cultivated area in 1956 (acres)						
Uzbekistan ..	..	..	..	..	..	3,212,000
Kirghizie ..	..	..	..	..	..	179,000
Turkenemi ..	..	..	..	..	..	472,000
Tadzhikistan ..	..	..	..	..	..	407,000
Azerbaidjan ..	..	..	..	..	..	496,000
Kazakstan ..	..	..	..	..	..	271,000

The Republic of Uzbekistan, which already produces close to 3 million tons of seed cotton, is scheduled to produce more than 6 millions under the expansion programme. Tashkent is the leading centre in this area. Cotton is cultivated in the valleys of two large rivers—the Syr Daria and the Amou Daria—which are important for supplying electric power and for irrigation purposes.

In the cotton growing areas of Uzbekistan two things are particularly noticeable. First, the physical characteristics and fertility of the land which can be adapted fairly easily to irrigation. Second, there is no evidence of any serious parasites as there is in the United States; attacks are limited to early damage by mites and thrips.

Without detracting from the effectiveness of the technical services directed toward improving cotton cultivation, these two factors—favourable soil and little disease—are responsible for the high average yield which is expected to show further improvement in the fairly near future.

At present 7·6 million acres of all crops are in cultivation in Uzbekistan of which 5·7 millions are irrigated. Irrigation is being rapidly extended, but up to now has been applied mainly to existing land and not to bring new land into cultivation. About 65 per cent. of irrigated land is sown to cotton and in certain areas cotton has been grown for six successive

\* Summary of a report by MM. E. Senn and J. Lhuillier on their mission to the U.S.S.R., to be published in *Coton et Fibres Tropicales*, periodical of the Institut de Recherches du Coton et des Textiles Exotiques, 29 rue d'Artois, Paris VIII. Reprinted by kind permission of the International Cotton Advisory Committee, Washington, from their monthly review (February 1958).

years. Cotton production in Uzbekistan is shown in the following table:

Year	Acre acres	Approximate yield (lb per acre)	Approximate production (1,000 bales)
1913 . .	1,040	378	823
1940 .	2,273	464	2,207
1956 .	3,212	679	4,364

One of the biggest problems in growing cotton in Russia is low temperatures. Early frosts have caused a reduction in yields during the present season. Geneticists are currently working on how to shorten the growing period for cotton.

Cotton production is regulated through the following organizations:

- (1) The Science Academy engaged in pure research and with problems not dealt with by the Uzbekistan Academy of Agricultural Science.
- (2) The Gosplan, chief of the Council of Ministers who plans and co-ordinates production activities—labour, raw materials, power, investment, etc.
- (3) The Council of Ministers of the Republic, a local political organization.
- (4) The Gosplan and the Council of Ministers of the Supreme Soviet which co-ordinates, on a national scale, the programmes set up by the 15 Republics.
- (5) The Minister of Agriculture of Uzbekistan who is responsible for putting into effect the decisions taken.
- (6) The "Sovkhozes," the "Kolkhozes" and the tractor machine stations which are concerned with the actual carrying out of the production plans.

The Sovkhozes are State farm enterprises whose scale of operation is large enough to justify a completely independent organization under the control of the Minister of Agriculture of each Republic. There are about 100 sovkhozes in Uzbekistan and 5,000 in the U.S.S.R. as a whole. Kolkhozes are collective farms which cultivate relatively small areas individually. There are 1,900 kolkhozes in Uzbekistan served by about 250 tractor stations. In 1956, 80 per cent. of the total earnings of the kolkhozes in Uzbekistan came from cotton.

The system of cotton pricing in Uzbekistan consists of two elements—the base price which relates to a theoretical yield for any given region and the other, in the nature of a productivity premium. In the case of cotton, every quintal produced in excess of "norm" benefits from a 50 per cent. premium above the base price. Normal production of seed cotton per acre varies according to the region, being 1,300 lb. in the less favourable areas, rising to 1,750 lb. in the Boukhara area and 2,200 lb. in Tashkent.

The seed cotton prices paid for extra long staples are double those paid for average staples, and in 1957 the quality differentials were widened.

Higher margins for quality are designed to raise the standard of production and this policy has been very successful. In Uzbekistan

64 per cent. of the total crop in 1956 was of first quality compared with 46 per cent. in 1940.

In this method of price fixing, it is necessary to fix a base price which is sufficient to cover all legitimate costs incurred by the average producer and production premiums must be set at levels which can reasonably be attained by producers. The results of this price policy can be assessed in the fact that in 1956 only 270 of the 1,900 kolkhozes in Uzbekistan produced less than 1,300 lb. seed cotton per acre compared with 485 in 1955. The aim is to reduce the present 96 work days per acre to 20-25 days by 1960, which would make more labour available for other work.

Tashkent is the basic cotton research centre where the Cotton Institute of Tashkent and the Institute of Genetics and Plant Physiology are the two most important research bodies.

The main medium staple variety in the U.S.S.R. is 108F. About 83 per cent. of the total cotton acreage in Uzbekistan and the whole of Azerbaijan and Kazakhstan is planted with this variety. 108F comprises about 75 per cent. of the total cotton crop in the U.S.S.R. The staple length is 32-33 mm. ( $1\frac{1}{2}$  in.). Long staple varieties are 2 i 3 and 54-76 i., having a staple length of 41 mm. ( $1\frac{1}{2}$  in.) and 38-40 mm. ( $1\frac{1}{2}$  in.- $1\frac{9}{16}$  in.) respectively, but these are being replaced by new varieties. Earlier yielding varieties, 6022-6015, are being introduced with staple length of 40-41 mm. ( $1\frac{9}{16}$  in.- $1\frac{5}{8}$  in.) and with greater resistance to wilt and better technical qualities.

The Institute of Mechanization for Central Asia, established in 1957, is primarily concerned with cotton mechanization. To date, only 12·7 per cent. of the total crop in Uzbekistan is harvested by machine. Aside from harvesting, machines are in use for sowing, hoeing, thinning and defoliation.

The Irrigation Institute for Central Asia was set up in 1925 to study the possibilities for controlling and distributing water supplies. Drainage poses many problems: heavy loss of water from the canals, flooding and the salinity of the land.

The irrigation potential in the cotton growing areas is of the order of 25 million acres compared with the 5·7 million acres presently under irrigation. A limiting factor in the development of irrigation is the need to modernize the old irrigation system as well as providing for planned extensions. About 60 per cent. of the old system has been brought up to date, leaving about 2,224,000 acres still to be modernized and about 1,235,000 acres under the expansion programme planned to 1965. Canal construction covers about 74,000 acres, but potentially this could easily be expanded to cover 247,000 acres.

The two biggest problems which the U.S.S.R. has to face in achieving its production targets are, on the one hand, land recovery and development and the elimination of salinity and, on the other, harvesting. Most of the good land is already being cultivated. Harvesting problems relate to the development of mechanical picking and the need to dry cotton made necessary by the fact that gins are operating through ten months of the year.

## DECLINE IN THE COTTON SURPLUS

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It seems certain that the 1957-58 cotton season whose end is now approaching will see not only a further diminution of the world surplus of the commodity but also a materially larger diminution than occurred in 1956-57. This prospect emerges mainly because total production proves to have been smaller than was originally expected in many countries—particularly the United States—and smaller also than the actual production last season and the season before that. Among the more important producing countries unusually high yields per acre, which had been a prominent feature in recent seasons, were less numerous, suggesting that, though the gradual improvement in seed and in methods of cultivation continued, weather played a greater and less helpful part in determining the outturn of the crops.

On the other hand, consumption has expanded no further, and, indeed, seems likely to have had its first contraction for some years. The increase in the world's cotton textile productive capacity and its spread to countries where previously there was little or none has contributed to a further change in its distribution as between the East and the West. Much of the machinery in the West is falling idle and some of it is being scrapped, while elsewhere the general pattern is continuous operation on two or three shifts a day six or seven days a week. There are indeed grounds for believing that there is at present over-production of cotton goods in the world as a whole, and this seems likely to cause much difficulty, as many of the Eastern countries which are running their cotton mills to full capacity have not a sufficiently diversified economy to absorb the workers who would become redundant if textile activity was curtailed.

TABLE I.—FREE WORLD COTTON SUPPLY  
(In million bales of 478 lb. net, except American in running bales)

	1953-54	1954-55	1955-56	1956-57	1957-58(a)
United States:					
Stocks .. ..	5.6	9.7	11.2	14.5	11.4
Production .. ..	16.4	13.6	14.7	13.0	10.9
Total .. ..	22.0	23.3	25.9	27.5	22.3
Other countries:					
Stocks .. ..	10.4	9.3	9.4	7.6	9.3
Production .. ..	14.0	16.0	16.1	16.0	16.4
Total .. ..	24.4	25.3	25.5	23.6	25.7
Total free world supply	46.4	48.6	51.4	51.1	48.0

(a) Provisional

Source: International Cotton Advisory Committee

With a larger decrease in new production than in consumption, stocks have decreased, though the decrease has not been general. It has been

most strongly marked in the United States, whose policy of selling the Commodity Credit Corporation's stocks for export against competitive bids has enabled it to retain the predominance which it re-established for itself in 1956-57 in international trade in the commodity. United States exports are lagging somewhat behind last season's, but they have remained large enough to exert a decisive influence on the volumes and prices of the overseas sales of American-type outside growths. The longer-stapled cottons have been in rather different circumstances, and two or three of their principal producers will end the season with larger unsold stocks than they had at the beginning.

Stocks in the free world on August 1, 1957, are put at a total of 20·7 million bales, compared with 22·1 million bales a year previously, while production is estimated at 27·2 million bales, compared with 29 million bales. This shows a decrease of some 3 million bales in the total supply, while consumption, which rose from 28·5 million bales in 1955-56 to a new high record of 29·4 million bales in 1956-57, seems unlikely to lose all last season's gain. A decrease of at least 2½ million bales in total stocks therefore seems to be indicated.

TABLE II.—FREE WORLD PRODUCTION OF RAW COTTON  
(In thousands of bales of 478 lb. net, except American in running bales)

	1934-38 Average	1953-54	1954-55	1955-56	1956-57	1957-58
United States ..	12,389	16,402	13,630	14,685	13,029	10,880
Mexico ..	302	1,215	1,815	2,240	1,800	2,140
Salvador ..	4	60	94	132	130	140
Nicaragua ..	3	105	205	160	190	200
Brazil ..	1,793	1,465	1,635	1,700	1,350	1,250
Argentina ..	275	650	500	520	500	650
Peru ..	386	547	469	430	450	430
Egypt ..	1,846	1,467	1,605	1,541	1,498	1,825
Sudan ..	245	415	405	440	620	285
Uganda ..	273	320	265	304	315	270
French Equatorial Africa ..	34	140	150	160	165	175
Mozambique ..	27	155	140	100	140	150
Tanganyika ..	45	41	84	101	109	145
Kenya ..	13	12	12	11	11	11
Nyasaland ..	12	12	12	4	10	10
Union of S. Africa ..	2	20	34	28	32	32
Nigeria ..	47	135	170	140	145	185
Belgian Congo ..	160	235	220	245	230	230
India ..	} 5,320	{ 3,770	4,425	3,880	4,080	4,225
Pakistan ..			1,200	1,310	1,425	1,400
Burma ..	95	100	85	85	80	80
Iran ..	161	230	275	275	285	280
Iraq ..	9	17	30	35	35	45
Turkey ..	240	620	630	600	650	550
Syria ..	25	225	365	401	428	450
Greece ..	75	140	190	280	235	255
Total (a) ..	24,207	30,319	29,418	30,757	28,900	27,200

(a) Including other free countries

Source: International Cotton Advisory Committee and Official Statistics

The position in the United States is particularly important because it will help to determine Washington's policy which, in its turn, exerts a big influence on the world price level of American-type cottons generally and on the scope for exports from the countries which produce the outside growths. Stocks in the United States decreased by 3·1 million bales in 1956-57, while the last crop was 2 million bales smaller than the previous one, making a total decrease of 5·1 million bales in the supply there.

Domestic consumption is expected to be some 600,000 bales less, and exports 1·9 million bales less, so that stocks at the end of the season should show a further decrease of 2·6 million bales. This would leave a total of some 8·7 million bales. A large proportion of this stock, especially that held by the Commodity Credit Corporation, is believed to be very poor in quality, particularly in grade, but even so the carry-over still cannot be regarded as inadequate.

TABLE IIa.—PRODUCTION OF LONG STAPLES  
(In thousands of bales of 478 lb. net.)

	$1\frac{1}{2}$ in. to $1\frac{3}{8}$ in.	Over $1\frac{3}{8}$ in.	Total $1\frac{1}{2}$ in. and over
Average 1934-38 .. .. ..	3,341	821	4,162
1951-52 .. .. ..	2,313	938	3,251
1952-53 .. .. ..	2,473	1,432	3,905
1953-54 .. .. ..	2,624	1,005	3,629
1954-55 .. .. ..	2,645	1,018	3,663
1955-56 .. .. ..	2,806	1,095	3,901
1956-57 .. .. ..	2,606	1,391	3,997
1957-58 (a) .. .. ..	2,723	1,231	3,954

(a) Provisional

Source: International Cotton Advisory Committee

For the third year in succession production of long-stapled cottons has remained virtually unchanged.

Two or three of the producing countries, especially Egypt, have increased their exports, but in general the offtake has been hindered by spinners' opinion that unduly high prices were being asked for the cottons and by suspicion arising from the circumstance that different prices were quoted by Egypt to different customers and that much Egyptian cotton was sold to Communist countries, which tend to re-sell surplus supplies to third parties. Some influence has also been exerted by the movement, especially strongly marked in the United Kingdom, to use medium counts of single yarn spun from good-grade American-type cotton, or synthetic fibres either alone or in blends, as a substitute for fine twofold yarns produced from long stapled cotton. In one way and another demand has fallen a good deal short of expectations, and there would no doubt have been a considerable expansion in the carry-over of these cottons but for the very serious decrease in the outturn of this season's crops of Sakel and Lambert types in the Sudan.

**Big Falls in some Crops**

The greatest change on the production side this season has been in the United States crop, which fell short of last season's by some 2·1 million bales. Whereas last September it was estimated at 12,713,000 bales, with an indicated yield per acre of the staggering figure of 446 lb. (against the record of 417 lb. in 1955-56), the final returns showed only 10,880,000 running bales, with a yield per acre of 388 lb., compared with last season's 409 lb. This year's crop has got off to a poor start, with unfavourable weather in many districts. On the whole, however, conditions have been more unfavourable in the eastern and central areas than in the west where yields are highest. Last year's cultivated area is given as 14,066,000 acres, out of a total allotment of 17,585,000 acres, withdrawals from this allotment under the Soil Bank scheme being some 3,030,000 acres. For the current year the allotment is 17,555,000 acres, and the Soil Bank is expected to remove some 5 million acres from this total. Mr. E. T. Benson, the United States Secretary of Agriculture, has pointed out that, under existing legislation, the total allotment in 1959 may be no more than 14 million acres, and he uses this prospect as an argument in favour of new measures which would permit a lower support price and a larger acreage allotment.

Estimates of Mexican production have also had to be reduced since the beginning of the season, but nevertheless the crop is likely to go a considerable way towards recovering from the setback of 1956-57. Nicaraguan production is little changed, though some decrease had been expected in view of a reduction in the acreage, and in Salvador also the crop is of much the same size as last season's. Colombia shows a slight decrease, but most of the other smaller Latin American countries have at least maintained their production, and Guatemala has achieved a new high record. Acreage has been reduced in Brazil this season, but with more careful cultivation higher yields are expected, and the total outturn will be about the same as in 1956-57, though smaller than in several of the immediately preceding seasons. Argentina, with a record acreage, shows an increase of about one-quarter in its crop, establishing a new high record, but there has been a small decrease in Peru.

Total production in Europe has not made much further progress. Spain has failed to maintain last season's sharp increase, while Italy and Greece, though both growing larger crops than in 1956-57, have not recovered the record figures of 1955-56. There has been a rather sharp setback in Turkey, where the crop has been the smallest since at least 1950-51, but Syria has made further progress to a new high record, and its new longer-stapled variety—Palmyra—has aroused much interest. Israel's production of some 20,000 bales this season has included 800 bales of a long-stapled variety which has been bought by a Lancashire spinning combine. There has again been little change in Iran, but the crop in Iraq has made a rather larger proportional increase than in the previous two or three seasons.

Some marked contrasts have arisen in Africa. The crop in Egypt is the largest since 1952-53, with increases compared with last season of about 600,000 kantars both in the extra-long and the medium-long varieties,

but with a decrease of 200,000 kantars in the middle group. The Sudan, on the other hand, has experienced a big reduction in its total crop. Production of American types has been doubled compared with last season, but estimates of the production of long staples have had to be revised downwards continuously as the season has proceeded, and the total of Sakel and Lambert types is now put at some 220,000 bales, compared with 585,000 bales—the high record—in 1956-57. Uganda also shows a sharp decrease, though not as large a one as was expected earlier in the season, when the ill-effects of a severe drought were perhaps over-estimated. Nigeria, Tanganyika and the French African territories have all made further progress to new high records, and there has been some recovery in Mozambique and Angola, but production in the Belgian Congo has remained at last season's level.

The Indian crop has again increased slightly, though it has not yet been restored to the 1954-55 level. A smaller acreage was cultivated in Pakistan, but with favourable conditions the yield per acre has been brought up to over 200 lb., and there has been a slight increase in the total outturn.

TABLE III.—FREE WORLD CONSUMPTION OF RAW COTTON  
(In thousands of bales of 478 lb. net)

	1934-39 <i>Average</i>	1953-54	1954-55	1955-56	1956-57	1957-58 <i>1st half</i>
United States ..	6,454	8,576	8,835	9,141	8,617	4,224
Canada ..	268	305	355	381	372	179
United Kingdom ..	2,741	1,834	1,750	1,545	1,575	641
France ..	1,203	1,336	1,268	1,215	1,375	434
W. Germany ..	1,195	1,222	1,246	1,318	1,431	577
Italy ..	685	875	804	765	883	329
Belgium ..	357	430	428	415	452	189
Spain ..	235	320	400	397	420	N.A.
Netherlands ..	244	322	334	337	351	85
Sweden ..	134	135	136	135	140	62
Portugal ..	90	194	214	203	199	79
India ..	} 3,036	{ 3,985	4,100	4,063	4,290	1,760
Pakistan ..						
Japan ..	3,441	2,441	2,120	2,322	2,844	897
Hong Kong ..	—	204	218	223	232	91
Total (a) ..	22,270	26,854	27,566	28,480	29,400	N.A.

N.A. Not available

(a) Including other free countries

Source: International Cotton Advisory Committee and Official Statistics

#### Mill Activity Curtailed

Cotton textile trade in a great many countries, especially in the West, has been disappointing in recent months, and mill consumption of the fibre has lagged behind last season's. The fall has been especially strongly marked in North America. In the United States, mills used in the first eight months of the season 5,445,000 bales, against 5,959,000 bales a year previously, and Canadian consumption in the seven months ended February was 205,000 bales, against 230,000 bales. Western

European consumption was fairly well maintained in the first half of the season, but since then a decline has become clearly apparent, especially in the United Kingdom, as fresh business in yarn and cloth has slackened continuously over the last nine or ten months. For some time orders already on the books kept mills fairly busy, but activity has been curtailed by short-time working to an increasing extent since the turn of the year, and the current rate of consumption is much lower than that six or seven months ago. Belgium, the Netherlands and Italy, as well as the United Kingdom, show considerable falls.

Expansion has continued in Pakistan and Hongkong, and the mills in India have maintained a high level of activity, though latterly they have had increasing difficulty in disposing of their output and this may lead before long to some slackening of the pace. The reversal of the previous trend towards the recovery of the pre-war volume of cotton textile production in Japan has become more strongly marked. Though textile exports have increased there has been a considerable accumulation of stocks, and the Government has taken steps to relieve the situation by reducing cotton imports, while the spinners have reverted to the system adopted during the thirties of sealing a proportion of their spindles so that they could not be operated. At the moment 30 per cent. of the spindles are withdrawn from activity in this way.

In South America a slow expansion in consumption continues in spite of a check imposed by labour troubles in the Brazilian industry and occasional political disturbances. There are increases also in the Middle East and in Africa as more textile machinery is installed and brought into operation. In these countries, unlike those of Europe and North America, demand for textiles is affected little if at all by any uncertainty which may arise in the world market about the course of cotton prices.

### **Smaller Exports from most Countries**

In 1955-56 the United States contributed some 2·2 million bales to the total of 13 million bales of cotton which entered into world trade, whereas

TABLE IV.—EXPORTS OF RAW COTTON  
(In thousands of bales of 478 lb. net)

	1934-38 <i>Average</i>	1953-54	1954-55	1955-56	1956-57	1957-58 <i>1st half</i>
United States	..	5,018	3,761	3,146	2,215	7,593
Mexico	..	105	948	1,248	2,018	1,304
Brazil*	..	1,065	1,402	1,040	815	375
Peru	..	337	395	354	491	400
Egypt	..	1,744	1,491	1,086	1,439	928
Sudan	..	257	415	299	561	334
India	..	2,746	{ 104	210	554	250
Pakistan	..		{ 898	650	726	508
Turkey	..	77	377	233	142	226
Greece	..	—	29	68	181	149

\* Via Santos only (a) Five months (b) Four months

Source: International Cotton Advisory Committee

last season its share jumped to 7·6 million bales of a total of 15·8 million bales. It seems probable that in the season now ending both the American share and the world total will be somewhat lower again, at perhaps 5·7 million bales, and 14 million bales, respectively. United States overseas sales have again been under the stimulus of the Commodity Credit Corporation's sales of its stocks for export at competitive prices. By the end of April 5,645,000 bales had been sold in this way since March 1957, while by the same time sales for unrestricted use, which started at the beginning of the 1957-58 season, when the C.C.C. assumed the title to cotton unredeemed from the 1956-57 loan, had disposed of 1,722,000 bales. The net loan stock accumulated from the last crop is around 3·1 million bales, and it has been announced that sales will continue next season.

The high level of United States exports seems to have exercised a greater influence this season than last on the volume of exports from other countries which produce American-type cottons. In some instances, however, including Brazil, Turkey and India, the appearance is deceptive because exportable surpluses have been smaller. On the other hand, Argentina, Syria, Pakistan, Tanganyika and Nigeria have had more to sell abroad and have had indifferent success in disposing of their surpluses. East and West African cottons have moved off rather slowly, though prices have been adjusted to the state of the market, and Pakistan's exports to the end of April were little more than two-thirds of those in the corresponding period last season, mainly because of the high prices asked. The response to the Indian cotton made available by the season's export quotas has caused some disappointment, but Mexico has been able to maintain its overseas sales.

Peruvian exports have been facilitated by the attractiveness of the prices to overseas customers as a result of the favourable exchange rates, and also by the widespread reluctance to buy Egyptian and Sudan long staples. The latest Aden crop is the first for several years which has not been the subject of a bulk purchase by the British Government, and it is understood that so far no considerable quantity of it has been sold.

### Weaker Markets for Long Staples

In recent months there has been a rather sharp distinction between the course of prices of American-type cottons and that of the longer-stapled varieties. The highly complex system of price-supports, sales from stocks, etc., in the United States has kept prices of Upland types from all sources fairly steady, and there has been underlying strength in prices of the better grades because the last United States crop, though on average long in staple, was also low in grade, while the average grade of the C.C.C. stocks available for sale declined perhaps even more rapidly than their total volume.

United States markets have made no very great or lasting response to developments in Washington's policy for cotton prices and export sales. In February it was announced that the loan rate for the 1958-59 crop would be based on 81 per cent. of the mid-January parity price of 37·96 cents, making a rate of 30·75 cents for middling  $\frac{1}{2}$  inch (compared with

28·81 cents—78 per cent. of the parity—for 1957-58), while in May the United States Department of Agriculture further announced that the premium for middling 1 inch would be 385 points, making the loan rate for that quality 34·60 cents, against 32·31 cents this season. Between these two dates it was announced that for 1958-59 there would be a continuance of the sales from C.C.C. stocks against competitive bids, but that there would also be an export subsidy, payable in kind, which the exporter must utilize for buying cotton from the C.C.C. stock: this cotton also would have to be exported. The initial amount of the subsidy was eventually announced as 6½ cents per pound, confirming earlier expectations that it would be fixed at a level which would equate the costs to overseas customers of cotton bought from ordinary trade sources with that of cotton bought from the C.C.C. It has been intimated, however, that the rate may be changed from time to time, perhaps without notice, and that in its computation regard will be had to the prices at which comparable outside growths can be bought.

The prices of American-type outside growths have been fairly well maintained, though both India and Pakistan have had difficulty in achieving a satisfactory equilibrium between the prices and the volumes of their exports, particularly of desi qualities. On March 4 the Pakistan Government thought it desirable to issue a denial that it contemplated making a reduction in its export duty on desi cotton, while ten days later the Indian Government reduced its export duty on Bengal desi from Rs. 100 to Rs. 50 per bale, at the same time providing an export quota of 50,000 bales of grades not above fine in addition to the original one of 100,000 bales. Selling in Uganda and Tanganyika has been sluggish at times, and the Kampala Lint Price Committee, which fixes local prices for the cottons of both these territories, made a general reduction of 2 cents per pound in March for both spot and forward delivery.

New regulations regarding foreign exchange in Peru at the turn of the year permitted substantial reductions in the prices which could be quoted both for Tanguis and for Pima for export, and foreign buyers have taken full advantage of the reductions, which have made Peruvian growths highly attractive.

In the Sudan the halving of the export tax in November, when the Gezira Board reduced the reserve prices for its Khartoum auctions for the third time last year, did not stimulate sales for very long. The export tax was reduced again from 3½d. to 2½d. per pound in March and there were at the same time changes ranging from reductions of 4½d. to increases of ½d. per pound, in the Gezira Board's reserve prices. When the auctions were resumed demand broadened again, but after a few weeks it declined once more, even the increasing indications that this year's Sakel and Lambert crops were a failure proving incapable of restoring sales to a completely satisfactory volume.

Prices in Egypt have had an easy undertone almost throughout the current season, export sales not having increased sufficiently to offset the increase in supplies resulting from the heavy carry-over from 1956-57 and the substantially larger crop. The Egyptian Government's hand was forced by the changes in the Sudan's sales and export arrangements, and

on March 26 it also reduced its export duty by 1½d. per lb., making the new rates 5½d. for long staples and about 2½d. for Ashmouni types. At the same time it offered to pay guaranteed minimum prices of 78 tallaris per kantar for Karnak and 66½ tallaris for Ashmouni in respect of cotton remaining unsold at the end of this season. These rates compare with the previous minimum support prices of 69 tallaris for Karnak and 55 tallaris for Ashmouni. A few days before these changes the Government had introduced a system under which a discount of 23 per cent.—later reduced

TABLE V.—SPOT PRICES, INCLUDING EXPORT TAXES, IN CERTAIN COTTON MARKETS  
(Equivalent cents per lb.)

	U.S.A.		Mexico	Pakistan	Peru	Egypt	
	Midd. 1 in.	Midd. $1\frac{1}{8}$ in.	Matamoros Midd. $1\frac{1}{8}$ in.	Karachi 289F Punjab	Lima Tanguis Type 5	Alexandria Karnak Good	Ashmouni Good
Averages:							
1953-54 ..	34.36	35.08	N.A.	32.69	37.05	46.57	37.44
1954-55 ..	35.02	36.17	34.22	33.57	36.72	51.19	41.17
1955-56 ..	N.A.	N.A.	31.59	31.65	33.87	(a) 54.76	(a) 41.23
1956-57 ..	† 27.07	† 28.53	29.69	30.25	36.95	(a) 62.22	(a) 47.36
1957-58:							
August ..	† 26.10	† 27.30	28.24	29.79	35.44	55.37	44.41
September ..	† 26.23	† 27.44	28.94	28.22	37.94	N.A.	44.18
October ..	† 26.34	† 27.66	29.06	27.10	38.99	N.A.	48.15
November ..	† 26.54	† 27.98	29.87	30.02	38.20	N.A.	N.A.
December ..	† 26.90	† 28.42	29.91	32.75	38.20	69.27	49.63
January ..	† 27.09	† 28.65	30.39	33.07	38.52	68.51	50.84
February ..	† 27.26	† 28.72	31.13	32.70	36.89	65.75	51.08
March ..	† 27.41	† 28.96	31.31	31.48	36.29	63.05	49.63
April ..	† 27.66	† 29.20	30.60	31.36	35.32	61.77	47.05
May ..	† 27.75	† 29.27	30.11	29.87	35.52	59.74	45.45
June ..	† 27.75	† 29.32	28.67	28.15	34.79	59.42	45.60
July ..	† 27.86	† 29.49	28.01	28.51	37.29	57.06	44.94
1957-58:							
August ..	† 27.89	† 29.55	27.79	29.62	36.11	56.26	44.41
September ..	† 27.27	† 28.93	27.61	30.25	32.30	N.A.	44.43
October ..	† 27.29	† 28.98	28.54	29.91	30.44	N.A.	44.21
November ..	† 27.69	† 29.57	30.42	30.19	30.86	54.81	44.60
December ..	† 28.22	† 30.13	30.93	29.83	30.86	56.86	45.60
January ..	† 28.44	† 30.27	29.98	30.31	N.A.	53.59	44.77
February ..	† 28.32	† 30.11	29.69	29.95	30.19	49.79	42.98
March ..	..	† 28.18	† 29.91	29.85	28.69	48.92	41.87

N.A. Not available

(a) Average for less than 12 months

† Minimum C.C.C. sales price at Houston for export

Source: International Cotton Advisory Committee

to 21 per cent.—was available for sales for export against payment in all hard currencies, including sterling. The Bank of England will still not provide foreign exchange for United Kingdom traders to pay for Egyptian cotton, even if bought from a third country, and there can be little doubt that the absence of British demand weighs on the Alexandria market, though France has now resumed purchases from Egypt, and demand from the Communist countries is surprisingly well maintained.

### Setback in Rayon

During the past half-year most of the textile industries in various parts of the world have for one reason or another found trade difficult. In cotton, indications of over-production of cloth, and in wool, lack of confidence in the price of the raw material following weakness at the Dominion auctions, have been unfavourable influences. The man-made fibres, especially rayon, have also had their difficulties, and theirs has no longer been a story of continued expansion. Production at a great many works has been curtailed to a level well below capacity in the United Kingdom, several Western European countries, the United States and Japan.

In the United Kingdom total production of filament yarns and staple fibres increased last year by only 13 million lb. compared with 1956. Output of filament yarn increased by  $5\frac{1}{2}$  million lb. to  $232\frac{1}{2}$  million lb., and that of staples by  $7\frac{1}{2}$  million lb., to 263 million lb. The totals include about 2 million lb. of protein fibres and about 50 million lb. of wholly synthetic fibres. In the first quarter of this year the output of filament yarns was 52.8 million lb., compared with 59.9 million lb. in the corresponding period of 1957, and that of staple fibres was 60.6 million lb., compared with 68.9 million lb.

TABLE VI.—APPAREL FIBRE CONSUMPTION  
(In thousands of metric tons.)

	1957	1956	1955	1938
Cotton .. .. ..	8,600	8,370	7,948	6,200
Wool .. .. ..	1,350	1,294	1,192	945
Rayon .. .. ..	2,500	2,479	2,350	875
Synthetic fibres .. .. ..	400	300	250	(a)
Total .. .. ..	12,850	12,443	11,740	8,020

(a) Included in rayon.

Source: United Nations Food and Agriculture Organization.

What seems to be the almost universal trend was clearly apparent in production in the United States last year. Output of rayon yarn fell 35 million lb., to 714 million lb.; that of rayon staple increased by only 27 million lb., to 425 million lb.; while other yarns and staples took a big leap forward, increasing by  $55\frac{1}{2}$  million lb., to 625 million lb., representing well over one-third of the total output of the man-made fibre industry there, compared with little over one-quarter two years previously.

Another pointer to the decline in rayon is provided by figures of world consumption of apparel fibres. The total consumption of those fibres in 1957 is estimated to have increased by about  $3\frac{1}{2}$  per cent. compared with 1956—incidentally the annual rate of increase of the world's population is only about  $1\frac{1}{2}$  per cent.—but consumption of rayon increased by less than 1 per cent., though that of the wholly synthetic fibres increased by one-third to 400,000 metric tons, out of the total for all fibres of 12,850,000

metric tons. The largest specific increase was that of 230,000 metric tons, to 8,600,000 metric tons, in cotton.

Rayon certainly seems to be losing ground in the trade in apparel—the demand for rayon for garment linings has fallen off to a puzzlingly large extent—though the effect on the total volume of trade is partly offset by the increasing development of its industrial uses. In the first quarter of 1958 the deliveries of rayon filament yarn in this country for industrial purposes were 12 per cent. greater than a year previously, in contrast to the decrease of 7 per cent. in total deliveries for all purposes, largely because of the recovery in the demand for tyre fabrics, thus indicating the importance of the tyre trade to the rayon industry.

The inroads of the wholly synthetic fibres into the industrial field are still restricted in the United Kingdom by the pressure on domestic supplies of demand from other sources. Considerable quantities, especially of nylon filament and terylene staple, are still being imported to help to meet the demand from British textile and other industries. Both these fibres, along with growing quantities of acrylic fibres, are being used extensively in cotton mills, alone and in blends, for the production both of apparel cloths and of furnishing fabrics.

*Received May 1958*

## INTERNATIONAL COTTON ADVISORY COMMITTEE

THE seventeenth Plenary Meeting of the International Cotton Advisory Committee was held in London from June 2 to 7.

Sessions were under the chairmanship of Mr. J. A. R. Pimlott, Under-Secretary, Board of Trade, who was also the head of the United Kingdom Delegation. A total of forty-eight governments, embracing virtually the entire world's cotton economy, were represented. This included thirty-two member countries, seven international organizations, and twenty-five representatives from sixteen observer nations. Total registration was 168.

The Committee is an inter-governmental organization to promote co-operation in the solution of international cotton problems and to afford its members a continuous understanding of the changing cotton situation throughout the world. Both cotton producing and consuming nations are members of the organization.

Complexities of the present world cotton situation stirred considerable discussion and the Committee noted the following salient points:

1. The world production of cotton during 1955-56 was an all-time record of 42.7 million bales. The production during 1956-57 was reduced to 41.3 million bales, although there was an increase in production outside the United States. In 1957-58, the reduction of about 2 million bales in the United States brought world production down to 39.3 million bales.

2. The consumption of cotton exceeded production by about 1 million bales during 1956-57 and the current year's estimates point to a further disappearance of about 2 million bales in excess of current production.

In subsequent deliberations the following observations on the situation were made:

The decrease in total world stocks has been accomplished primarily as a result of a drastic decline in production in the United States and a few other countries resulting mainly from a reduction in acreage and to a smaller extent from unfavourable growing conditions. It has been assisted by a decline in production in a few other countries and by an increase in consumption in most countries other than the United States of America.

The responsible and careful manner in which the United States Government have disposed of their surplus stocks of cotton has contributed to the restoration of a certain measure of confidence in world markets without causing the extensive disruption which was widely feared.

On the other hand, the opinion was expressed that if domestic cotton prices in the United States were lower, consumption in that country would be higher and this would result in a further improvement in the world cotton situation.

Reference was also made to the undesirable effects of dual pricing systems, export subsidies and special currency arrangements. It was felt by some countries that these arbitrary influences on the marketing of

cotton presented uncertainties that constituted an obstacle to the free movement of cotton in world markets and its expanded consumption. The desirability of a stable price for cotton at a reasonable level was re-emphasized.

Hopes were expressed that in due course Governmental policies would be such as to permit the normal operations of futures markets.

While some concern was expressed relating to the immediate outlook for cotton consumption in several countries where consumption has recently shown a decrease, it was pointed out that basic trends in population and income growth should assure a sound and steady expansion in the consumption of cotton and cotton textiles in years to come, provided the competitive position of cotton relative to other fibres is maintained.

Attention was drawn by some countries to the dangers of excessive expansion of acreage and production in certain producing countries at a time when acreage in other producing countries is subject to drastic limitations. On the other hand, some countries have pointed out the need and inevitability of planned expansion in acreage and production in certain areas.

Gratification was expressed at the favourable reception of market development programmes in ten importing countries under the sponsorship of domestic organizations, the United States Department of Agriculture and Cotton Council International. The cotton promotion efforts of the International Federation of Cotton and Allied Textiles Industries were also noted with appreciation. In the common interest of producers and consumers alike, other producing and consuming countries are invited to join in these promotional activities.

On the invitation of the representative for the United States of America, the Committee at its closing meeting voted to hold the 1959 meeting in Washington, United States.

## BOOK REVIEW

THE MAN-MADE FIBRES INDUSTRY. By R. Robson. Macmillan and Co. Ltd. 1958. 135 pp. 21s.

R. Robson, author of the recently published work on "The Cotton Industry in Britain," has now produced an account of the man-made fibres industry. It is rather more general in scope, not being restricted to the United Kingdom.

Those directly concerned with either the commercial or the technical side of the textile industry will undoubtedly find it warrants study; to others it offers an opportunity of acquiring a broad outline of the field covered by modern fibres. The processes of manufacture are briefly reviewed, followed by an account of, first, the early regenerated cellulose fibres and then the more recent synthetic fibres such as nylon and terylene. The organization of the man-made fibre industries in the various countries is described, and mention is made of the complex inter-relations and interests of the major groups of firms.

As a preliminary to considering the future, a study is made of the prices and costs of production of various fibres, supplemented by a body of tabulated data. It is pointed out that in many instances it is yet too early to compare production costs, because those for the newest fibres reflect heavy development charges and the increased expenses associated with initial relatively small plants. But the position does not appear to be entirely clear for the early fibres. For instance, in the United Kingdom the 1956 price of acetate rayon staple is nearly 40 per cent. more than that of viscose rayon staple, whereas in the U.S.A. the prices of these fibres are the same. It is possibly not surprising that the author refrains from hazarding forecasts on future tendencies in price.

The present and prospective competition with cotton is given short consideration. Some space is devoted to deriving data for typifying the cost of cotton production in high-wage, high-productivity countries such as parts of the U.S.A. and low-wage, low-productivity regions such as Uganda and Nigeria. He finally derives a figure of about 18 pence per pound for both sets of conditions, to which must be added the costs of ginning, marketing and shipping, about 4 or 5 pence per pound. The weakness in the argument is the magnitude of the fair return to the grower, the variable conditions from country to country and price differentials associated with corresponding quality differences. The author points out that, after taking various factors into account, rayon staple fibre can be sold economically at a cheaper price than cotton. Moreover, because of the additional processing and greater losses associated with the spinning of cotton, the cost of cotton yarn exceeds that of spun rayon by an amount which widens as the yarn count becomes finer. He then continues with a brief consideration of the various properties of fibres, endeavouring to link these with end-use requirements, and then touches lightly on the future economic position. Although disappointing to the reader, he is possibly wise in refraining also from forecasting future trends in relative production.

The book succeeds in presenting a broad picture of the past and present positions of the various parts of the man-made fibres industry. It is weakest in its supplementary information, on some of the technical and scientific data about fibres. But this is the easiest place to commit errors, particularly when it is not the main field of an author.

E. L.

## SPINNING TEST RESULTS

A BRIEF summary is given below of the main results of tests carried out recently by the Shirley Institute.

### LARGE-SCALE TESTS

	<i>Effective length</i>	<i>Pressley strength</i>	<i>Maturity ratio</i>	<i>Std. fibre weight</i>	<i>Count x strength</i>	<i>Yarn appearance</i>
<b>WEST INDIES 1956-57</b>						
<i>Antigua</i> .. .. ..	59	53.4	0.865	133	120s 2385	4
VH8 .. .. ..						
Check on the quality of multiplication stocks of VH8. The yarns were somewhat neppy, with strength intermediate between MSI and V135.						
<i>Montserrat</i> .. .. ..	52	48	0.82	160	1998	3
Check on the quality of multiplication stocks of MSI.						
<b>SUDAN 1956-57</b>						
<i>Egyptian types</i>						
Domains Sakel { S	46	49.3	0.925	155	1953	5
BAR 14/25	48	46.6	0.925	147	2043	4
X1730A ..	45	46.0	0.925	164	1560	5
BAR XL1	45	46.1	0.915	164	1672	5
BAR XL3	44	47.1	0.925	173	1602	5
BAR 4/16 ..	46	46.2	0.905	173	1635	5
BAR 5/6 ..	45	46.9	0.925	174	1600	6
Comparison of commercial and experimental varieties grown at Hag Abdulla.						
<i>Egyptian S types</i>						
Main crop. Grade G2S	48	47.1	1.015	143	2219	3
" " G4S	47	48.2	0.955	143	2167	4
" " G6S	45	46.3	0.89	154	2090	5
BAR 14/25 ..	49	47.9	0.95	143	2381	3
" " G4S	46	45.3	0.80	150	2197	6
<i>Egyptian L types</i>						
Main crop. Grade G2L	48	49.4	0.985	161	2043	4
" " G4L	47	47.5	0.97	161	1950	5
" " G6L	44	48.3	0.90	166	1767	5
X1730L1 Grade G2L	49	50.9	1.00	161	2070	3
" " G4L	47	49.2	0.98	162	1865	4
" " G6L	44	46.3	0.895	164	1850	5
Selection of commercial crop samples from Sudan Gezira Board.						
<i>American types</i>						
BAR 7/8.1 Roller ginned ..	36	—	0.90	164	1842	5
BAR 7/8.1 Saw ginned ..	35	—	0.905	172	1919	4
Sudan Government samples from Gedaref area, to test effect of roller and saw ginning on quality.						
<b>UGANDA 1957-58</b>						
Local BP52 .. ..	39	21.0	8.89	174	2062	5
Best of 3 BP52 lines .. ..	39	21.7	0.875	171	2073	4.5
Albar .. .. ..	39	20.1	0.875	215	1711	3
District Variety Trial, Nakasongola. The 64s yarns (not shown here) were fairly good in appearance; the 50s yarns showed rather more nep. Albar spun weakest, no doubt because of its higher standard fibre weight.						
Range of 7 BP52 { selections	42 to 39	22.0 to 19.5	0.93 to 0.855	164 to 179	2172 to 1908	2 to 5
Comparison of BP52 selections from Progeny Bulks Trial, Bukalasa.						

## SMALL-SCALE TESTS

	<i>Effect- ive length</i>	<i>Stelo- meter</i>	<i>Matur- ity ratio</i>	<i>Std. fibre weight</i>	<i>Count x strength</i>	<i>Yarn appear- ance</i>	<i>Neppi- ness*</i>
<b>WEST INDIES 1956-57</b>							
<i>Antigua</i>					<i>80s</i>		
VH8 Av. of 3 ..	62.6	30.3	0.89	129	2574	6.0	
VH10 Av. of 12 ..	56.4	26.4	0.88	149	2212	4.4	
VB32—Seabrook ..	53	30.1	0.90	141	2422	3.5	

Comparison of the 3 main VH8 strains, the 12 VH10 strains, and Seabrook received from the U.S.A. in 1951-52, which has been yielding well in variety trials.

						<i>40s</i>		
<b>NIGERIA 1956-57</b>								
Av. of 7 localities:								
Comm. 26C ..	35.1	17.7	0.798	220	1921	3.7	C	
1st Wave 26J ..	36.0	17.5	0.786	213	1956	3.8	C to D	
Av. of 26C and 26J:								
Samaru .. ..	37.0	18.6	0.817	218	2070	2.5	B to C	
Daudawa .. ..	36.0	18.3	0.857	223	1934	3.0	B to C	
Gombe .. ..	38.0	18.7	0.897	205	2215	1.5	A to B	
Gusau .. ..	33.0	16.0	0.675	216	1803	5.5	D to E	
Kano .. ..	35.5	18.1	0.870	218	1865	4.0	C	
Maiduguri .. ..	35.0	16.0	0.752	209	1829	5.0	D to E	
Kontagora .. ..	34.5	17.5	0.677	227	1856	5.0	D to E	

Extracts from tests on District Variety Trials samples, comparing 26C and 26J each averaged over 7 localities and their joint average performance at each locality. The Gombe samples were outstanding in all respects.

						<i>40s</i>		
Comm. 26C .. ..	36	18.2	0.87	217	1900	3	B	
2nd Wave 26J .. ..	37	18.4	0.83	207	2114	2	B	
New 26C reselections.								
Av. of 11 .. ..	36	18.3	0.925	210	1905	2.6	B	
New 26C reselections.								
Best of 11 .. ..	37	21.3	0.945	196	2269	1	A	

Comparison of various new small bulks of 26C origin with 26C and 26J, all grown at Samaru.

						<i>40s</i>		
<b>UGANDA 1957-58</b>								
Av. of 6:								
S47 (S) .. ..	41.1	20.2	0.910	176	2209	4.3	D	
BC177 .. ..	40.5	19.8	0.943	174	2192	3.5	C	
C (50) 20 .. ..	38.5	22.4	0.942	166	2449	2.6	C	

Comparison of 3 varieties grown at 6 localities. S47(S) and BC177 are both BP50 types; C(50)20 is a selection from BP52 made at Namulonge. Although C(50)20 is the shortest, it is abnormally fine for its length and has a high stelometer strength.

\*A=least nep. F=most nep.

## COTTON PRODUCTION ESTIMATES

TERRITORIES IN WHICH CORPORATION STAFF ARE WORKING  
(Bales of 400 lb.)

<i>Territory</i>						<i>Harvest completed</i>	1957	1958
Uganda ..	..	..	..	..	..	March	372,433	350,000
Kenya ..	..	..	..	..	..	March	7,959	11,300
Tanganyika:								
<i>Lake Province</i> ..	..	..	..	..	..	August	151,322	130,000
<i>Other Provinces</i> ..	..	..	..	..	..	November	16,400	22,900
Nyasaland ..	..	..	..	..	..	August	7,000	7,000
Nigeria ..	..	..	..	..	..	February	144,826	244,000
Sudan Republic:								
<i>Egyptian "S" and "L"</i> ..	..	..	..	..	..	May	661,544	196,000
<i>American Upland</i> ..	..	..	..	..	..	February	43,101	75,000
Aden ..	..	..	..	..	..	May	28,300	29,000
West Indies ..	..	..	..	..	..	April	3,739	6,700
Total ..	..	..	..	..	..		1,436,624	1,071,300

WORLD PRODUCTION\*

(Bales of 478 lb.)

		Season 1957-58	% of total
United States ..	..	10,900,000	27.8
Mexico ..	..	2,085,000	5.3
Argentina ..	..	650,000	1.7
Brazil ..	..	1,300,000	3.3
Peru ..	..	430,000	1.1
Egypt ..	..	1,825,000	4.6
Other Africa ..	..	1,621,000	4.1
India ..	..	4,225,000	10.8
Pakistan ..	..	1,435,000	3.6
Syria ..	..	460,000	1.2
Turkey ..	..	550,000	1.4
Europe ..	..	620,000	1.6
U.S.S.R. ..	..	5,700,000	14.5
China ..	..	6,200,000	15.8
Others ..	..	1,272,000	3.2
World total ..	..	39,273,000	100.0

\* From International Cotton Advisory Committee.

## ABSTRACTS

### COTTON IN AFRICA

#### Egypt

**134.** The final official estimate of the current crop compares with last season's final outturn as follows:

				<i>1956-57</i>	<i>1957-58</i>
				<i>Cantais</i>	<i>Cantais</i>
Karnak .. .. .. ..				2,132,282	2,118,844
Menoufi, Giza 45 .. .. .. ..				829,181	1,970,611
Giza 30 and 47, Dendera .. .. .. ..				1,317,940	1,144,332
Ashmouni, etc. .. .. .. ..				2,781,510	3,593,215
				7,060,913	8,827,002
					or about
					1,820,000 bales (478 lb.)
Scarto .. .. .. ..				169,366	194,001

Official information on the characteristics of new Egyptian varieties is as follows:

*Isis (Giza 45).* Selected from Giza 7 × Giza 28. Staple length 39-40 mm. Is now considered to be the best variety of Egyptian cotton, exceeding Amon in yarn strength by about 200 units.

*Ramses (Giza 59).* Selected from Menoufi × Giza 44. Staple length 37-38 mm. Yarn strength for 60s carded is 3,000. Considered to be the best substitute for Karnak though darker in colour.

*Giza 51.* Selected from Menoufi × Giza 40. Staple length 35 mm. Yarn strength for 60s carded is about 2,700. Could replace Menoufi and Giza 7.

*Lotus (Giza 47).* Selected from Menoufi. Could replace Giza 30, having similar staple length though superior yarn strength.

*Luxor (Giza 60).* Selected from Ashmouni × Menoufi. Staple length 32 mm. Is superior in yarn strength to Ashmouni, which it could replace in all uses, but is inferior in ginning outturn.

#### Sudan Republic

**135. 1956-57 Season.** Trade figures for 1957 compared with those for 1956 show a drop of £S19 million in the value of long staple cotton sales.

*1957-58 Season.* The harvest is expected to be unusually low. A statement issued by the Department of Agriculture shows that many adverse factors united to bring about the exceptionally low yield in the Gezira area. Foremost among these was the scanty and untimely pre-sowing and post-sowing rainfall, and the extreme heat throughout the after sowing period. These conditions encouraged the rapid multiplication of pests, principally flea beetle, at the early stage of the crop, followed by thrips in September, whitefly in October-November and jassid. Owing to the heavy demand on insecticides and sprayers, some areas were left without sufficient protection; moreover, the high October temperature caused the volatilization of DDT which would normally control flea beetle, thrips and jassid. Whitefly control is still in the experimental

stage, and the attendant high incidence of leafcurl disease was intensified by the delay in cleaning up the exceptionally heavy crop of the previous season in some areas. Wilt, too, was more widespread than ever before. Emphasis is laid on pest control and sanitation measures which it is hoped to enforce in the future.

The new Government ginning factory at Jebel Aulia, which cost £S600,000, went into production on March 16. Its 100 gins should be capable of dealing with 250,000 kantars per season. The Government ginnery at Port Sudan, which handles crops from the Gash Delta and Arbaat and a proportion of the Tokar crop, has been increased from 80 to 120 gins. Furthermore, two privately owned ginning factories, one of 62 gins and the other of 48 gins, are being built at Kosti. These additional facilities should be operating for the 1957-58 ginning season and should ease the pressure on existing factories. Hitherto anything larger than a medium crop has resulted in the ginning programme being prolonged into the rainy season.

Owing to a shortage of railway wagons, some of the 1956-57 crop was damaged by rain up country and unusually heavy rains caused further damage at Port Sudan where there was lack of storage space. Work is now in progress to extend the quays by 1,000 ft., which will allow the handling alongside of twelve to fourteen ships simultaneously. The Gezira Board have eight warehouses under construction, all of which should be available to handle cotton during 1958.

The first phase of the Managil Scheme, the South-west Extension, is nearing completion. Work by the Sudan Irrigation Department is on schedule and the system of canalization should be in operation by July 1958. The Sudan Gezira Board are preparing the area for sowing in August. In the April issue of the Review it was stated that this extension would increase the cotton area by 200,000 feddans. This statement was incorrect. It is in fact the irrigable area that will be increased by 200,000 feddans; the cotton area will be increased by approximately 60,000 feddans.

### **Belgian Congo**

**136. Rapport Annuel pour l'Exercice 1956.** (L'Institut National pour l'Etude Agronomique du Congo Belge, 1958. In French. Pp. 548. Price 160F.) This report covers the work carried out in the Belgian Congo under the direction of the Institute. Cotton experimental work was centred chiefly at the stations of Bambesa, Boketa and Mogombo in the Secteur du Nord; and at Gandajika, Kiyika and Lubarika in the Secteur du Sud. Details are given of the selection experiments carried out with the object of improving fibre qualities and conferring wilt resistance on the most suitable strains, and of trials concerning the effect of climate and date of sowing on the crop. Other investigations included spacing, rotation, manurial and insecticide trials and measures to improve general husbandry.

### **British West Africa**

**137. Nigeria. 1957-58 Season.** The season has been exceptionally good and it is expected that the crop will constitute a new record at over 244,000 bales (400 lb.). This estimate exceeds the previous record crop of 1954-55 by over 50,000 bales.

Exceptionally favourable weather, the wider distribution of improved seed, and better cultivation methods have combined to produce the

increased yield in spite of heavy damage due to stainer attack and bacterial blight in some areas.

### **British East Africa**

**138. Uganda.** The following table shows the valuation of the Uganda cotton crop through the past three years.

Season	Cotton lint		Cotton seed		Paid to growers £
	Bales of 400 lb.	Sales value £	Tons	Sales value £	
1954-55	299,935	16,296,775	87,651	2,206,051	11,490,000
1955-56	363,675	18,709,123	110,500	2,124,319	12,530,000
1956-57*	372,460	18,300,000	110,000	2,400,000	13,250,000

\* Provisional.

West Germany was the largest purchaser of the 1957 crop, buying 95,000 bales, more than a quarter of the total sales. The next most important buyer was India, taking just over 20 per cent. In the previous year India's purchases amounted to 60 per cent., and in 1955 to 75 per cent. The Lint Marketing Board stated that the main reason for the decline in Indian purchases was their acute shortage of sterling, which resulted in their making an agreement with the United States whereby they received 150,000 bales of cotton over a three-year period on very favourable terms. A new market for Uganda cotton is China, which bought 17,000 bales of the 1957 crop.

*1957-58 Season.* Earlier estimates of heavy damage caused by the severe drought have been revised, and the Department of Agriculture now estimates total production of AR and BR lint at approximately 350,000 bales. When the final price to growers was fixed last November at 58 and 57 cents per lb. according to type, it was expected to result in a drawing of £1,250,000 from the Cotton Price Assistance Fund, but in view of the fall in world prices this figure is likely to be as high as £1,500,000.

*1958-59 Season.* The guaranteed minimum price to be paid to growers for raw cotton in the 1958-59 season has been fixed at 46 cents per lb. Although this is 6 cents below last season's minimum, it is 4 cents higher than the current world price justifies, and is expected to cost the Price Assistance Fund a further £1 million. The actual prices to be paid to growers will be announced before the buying season opens in November. Through the past five years the difference between the guaranteed minimum and final prices have been as follows:

Season	Guaranteed minimum	Final price
1953-54	45 cents	51 cents
1954-55	47 "	61 "
1955-56	50 "	55-54 "
1956-57	50 "	56-55 "
1957-58	52 "	58-57 "

(1 E.A. cent = 0.12d.)

In the hope of increasing yields, the Department has launched a vigorous spraying campaign against *Lygus* in the Northern and Eastern Provinces and parts of Bunyoro, where it is a serious problem.

A cotton industries exhibition was organized at Kireka ginnery near Kampala in May to celebrate the Protectorate's fiftieth year as a cotton producer.

**139. Kenya.** The total Nyanza 1957-58 crop is estimated at 9,100 bales: the Malindi and Coast Province crops totalled 2,262 bales, making 11,362 bales (400 lb.) in all.

**140. Tanganyika. 1956-57 Season.** For the fourth year in succession a record crop has been harvested in the Territory, the figures from 1953-54 being 102,638, 122,058, 133,591 and 167,900 bales (400 lb.) respectively. The increase has largely reflected the rise in the Lake Province production which has expanded from an average of under 50,000 bales in the five years after the war to over 150,000 in 1956-57. The "Commonwealth Survey" reports that growers received approximately £4.5 million for their seed cotton in 1957, and it is shown that in the ten year period 1947-56 cotton exports increased in volume by 232 per cent. and in value from £780,000 to £7,480,000.

**1957-58 Season.** Owing to the excessive early drought this season's estimate for the Lake Province crop has been considerably reduced. Prospects for the Eastern and Tanga Province crops are generally good, however, and the provisional estimate for total production issued by the Department in May is as follows:

	<i>Bales (400 lb.)</i>		
Lake Province ..	..	130,000	
Tanga ..	..	3,000	
Northern ..	..	5,000	
Eastern ..	..	14,000	
Western ..	..	900	
Southern ..	..	35	
			152,935

The first auction sale of 1958 Lake Province cotton was held at the offices of the newly constituted Tanganyika Lint and Seed Marketing Board in Dar-es-Salaam in May. 10,000 bales were offered for sale and the prices received averaged 206.8 cents for Lakeside, 204.66 for Inland and 200 for Shinyanga ginneries respectively. A communication from the Board outlines several innovations and experiments scheduled to take place in the Lake Province, which it is hoped will improve the grade of the crop. Foremost among these is the establishment of the Ihale Ginnery zone as an experimental zone for the elimination of extraneous matter from the lint. No hessian or string is to be used for the transporting of seed cotton from the field through the primary market to the ginnery, and various types of canvas and twill bags and squares of different qualities and with different fastenings are being tried out. By this means it is hoped to discover the most satisfactory type of bagging and extend it over the whole Province for the following season. Further improvement is expected to result from the award of bonuses to ginners for pre-ginning classifying of Grade A seed cotton, and to co-operative societies (and through them to growers) for earlier picking and marketing.

The new African co-operative ginnery at Ushashi, 50 miles south of

Musoma, will be ready for the 1958 cotton season, and it is estimated that about 7,000 bales will be ginned there.

### Central African Federation

**141. Nyasaland. 1956-57 Season.** The average prices received for cotton lint, calculated f.o.b. Beira, were 27·95d. and 22·87d. per lb. for first and second grades respectively.

*1957-58 Season.* In the Northern Province an average yield of nearly 400 lb. of seed cotton per acre has been harvested and there has been a record return of Shs. 176 per grower. Elsewhere the crop has been badly affected by drought in the growing season and this, combined with subsequent bollworm and jassid attacks, has caused heavy shedding. It is unlikely, therefore, that the overall Protectorate crop will realize the 7,500 bales (400 lb.) originally estimated.

In the statement of the Government's production policy for the 1957-58 crop, proposals are laid down for the institution of alternate non-cotton years as a means of controlling red bollworm in the Central and Southern Province Lake-shore areas where production has decreased from an average of 1,250 tons through 1952-55 to an estimated 100 tons in 1957. Cotton is the only known host of the pest in Nyasaland, and it is hoped that this agricultural practice will starve it out. It is thought likely that the stainer population also will decline during the non-cotton year, since cotton is one of the most important foods for stainlers during the rains. A decline in stainer population would increase the percentage of No. 1 grade cotton.

Apart from the advantage of obtaining control of pests, an alternate year cropping policy would have the added attraction that uprooting could be delayed sufficiently to allow picking of later ripening bolls. Under the present régime a number of green bolls are still on the plants at the uprooting date.

### South Africa

**142.** In the Standard Bank Review it is reported that cotton picking in the Upington-Orange River area is in progress. Yields are regarded as fairly satisfactory and it is expected that the total crop will prove to be of average size. Reports from Barberton indicate that the incidence of bollworm is rapidly abating with the onset of colder weather. A crop about two-thirds of the normal size is expected from this area.

### Swaziland

**143.** According to Barclays Bank Review the current cotton crop looks promising. Ginnery returns show that the 1956-57 crop of 3,212 short tons constituted a record for the territory.

## COTTON IN AMERICA

### United States

**144.** According to the U.S. Crop Reporting Board the 1957 cotton crop totalled 10,964,000 bales (500 lb. gross). This compares with the 1956 crop of 13,310,000 bales and the 1946-55 average of 13,669,000 bales. The 1957 average lint yield per acre of 388 lb. was 21 lb. below the previous season's average, but 88 lb. above the 1946-55 average. The 1957 American-Egyptian crop was estimated at 81,900 bales (500 lb. gross). This compares with 50,300 bales last season and the 1946-55

average of 36,700 bales. The grade index of the 1957 crop was the lowest on record, but the average staple was the second longest. The crop contained the smallest proportion of Middling and higher grades since the 1949-50 season. Nearly a third of the 1957 crop was spotted cotton, the largest proportion in any crop on record. Cotton stapling  $\frac{5}{8}$  in. and shorter accounted for the smallest proportion of total ginnings on record. American-Egyptian cotton averaged lower in grade, but longer in staple, than in the previous season. The total Government-controlled stock at mid-May was approximately as follows:

1957 loan .. .. .. ..	3,094,817 bales
1956 and earlier crops .. .. .. ..	1,182,320 ,,,
Total .. .. .. ..	4,277,137 ,,,

Total mill consumption of the major textile fibres in 1957 amounted to 6,168 million lb. of which cotton accounted for 4,053,500,000. Over the 1940-57 period, mill consumption of rayon and acetate as a percentage of the total fibres used has increased from 9·9 per cent. to the latest level of 19·1 per cent., whereas cotton has declined from 81 per cent. to 65·5 per cent.

Allowing for the entry of nearly 5 million acres into the Soil Bank, the indicated 1958 planted acreage for Upland varieties is around 12,500,000 acres, with an expected yield of 10,750,000 bales.

**145. Extra Long Staple Cotton Production in the United States.**  
 J. C. Wilson (*Int. Rev. Cott. and Allied Text. Indus.*, 26, 101, 1958, p. 19.) Since the introduction of Supima in 1953, production of extra long staple cotton in the United States has increased steadily from 40,900 bales in 1954-55 to an estimated 82,000 bales in 1957-58. Supima, originally named Pima S-1, is a complex cross of Pima, Tangis and Upland strains, having a staple length of 1 $\frac{5}{8}$ -1 $\frac{1}{2}$  in. and a Micronaire fineness of about 3·63. Like other extra long staple cottons, it germinates slowly, has a long growing season and is susceptible to bacterial blight and *Verticillium* wilt. It is grown under irrigation in the American south-west, where the greatest possible use is made of machinery. At present most of the crop is hand-picked, but increasing use is being made of mechanical pickers of the smooth-spindle type. Both machine-picked and hand-picked cotton are roller ginned. Its comparatively low picking cost and relatively high yield (averaging 583 lb. lint per acre in 1956 and 566 lb. in 1957) give American growers an extra long staple cotton that can be sold profitably at competitive prices. The United States has thus become an exporter of this class of cotton after a lapse of nearly thirty years. In 1956-57 exports reached the all-time record of 58,000 bales. Moreover the American textile industry is now taking Supima for high count yarns, and whereas in 1954 home-grown fibre accounted for only 8 per cent. of domestic requirements of extra long staple, 60 per cent. of the total was American grown in 1956. This is in marked contrast to the period before 1954, when 90 per cent. of American extra long staple cotton passed into Government Loan.

**146. Summary of Fibre and Processing Test Results for Some Varieties of Cotton Grown by Selected Cotton Improvement Groups, Crop of 1957.** (U.S. Dept. Agric. Mktg. Serv., March 1958.) Results of tests on fibre properties and performance in processing of the principal varieties of cotton produced commercially by cotton improvement

groups for the 1957 crop are summarized in this report. Some of the varieties represented in the 1957 crop are reported for the same areas that were included in studies on the crops from 1946 onwards, thereby affording comparisons of test results over a twelve-year period through the results presented in reports for previous years. It is noted that through this period there has been a general improvement in fibre length, strength and fineness, with a resulting increase in average yarn strength.

### COTTON IN ASIA AND AUSTRALIA

#### Iran

**147.** Owing to unusually unfavourable weather, the 1957-58 cotton crop amounted to only 62,000 metric tons (248,000 bales, 500 lb.), the average quality of which was disappointing. It is expected that 260,000 hectares will be planted for the 1958-59 crop, which should produce about 280,000 bales if the growing season is normally favourable.

The approximate distribution of type is as follows: Cokers 112,000 bales, Hundredweight 10,000, Filistani 61,000, Americai 66,000 and Boomi 16,000. The variety Hundredweight is rapidly increasing in popularity. Growers have started to sow it in place of Filistani not only in the Caspian Coast region but also in Khorassan and the south.

The raw material requirements of the domestic cotton textile industry are increasing rapidly. By the end of 1958 the productive capacity will be raised to 526,000 spindles and 12,338 looms, as compared with 223,600 spindles and 2,600 looms operating six years ago. Domestic consumption for the 1958-59 season is estimated at 120,000 bales.

#### Aden

**148. 1957-58 Season.** The crop of Sudan "L" type cotton enjoyed excellent growing conditions and comparatively light pest damage. Total production is expected to be about 29,000 bales (400 lb.), of which 17,000 will come from Abyan and outside areas and 12,000 from Lahej. The crop is expected to include a higher proportion of Grades 2 and 3 than in recent years.

Ginning of the Abyan scheme cotton is progressing smoothly; the re-equipped ginnery in the Lahej district will be operating this season, and the combined output of the two installations will approach 2,000 bales weekly.

#### India

**149.** In a brief review of the advances in plant breeding and genetics in relation to the improvement of the cotton crop in India through the past twenty-five years, contributed by the Director of the Indian Agricultural Research Institute to the Anniversary Number of the *Empire Journal of Experimental Agriculture*, it is stated that adaptations to local conditions and improvement in yield, ginning outturn, staple length and spinning quality have been the principal objectives in breeding work on the three species in cultivation, namely *Gossypium arboreum*, *G. herbaceum* and *G. hirsutum*.

*G. arboreum* and *G. herbaceum* are indigenous species which have been cultivated in India since ancient times and are grown generally throughout the rainfed areas. *G. hirsutum* was introduced from the New World in the eighteenth century, and does well only under irrigation or conditions of assured rainfall.

At present only 23 per cent. of the average annual output of 4 million bales (400 lb.) is of short staple ( $\frac{1}{16}$  in. or below) as compared with 75 per cent. in 1933, and there has been a corresponding increase in the area under medium ( $\frac{1}{16}$ - $\frac{1}{8}$  in.) and long ( $\frac{1}{8}$  in. and above) stapled cottons, largely due to improved *hirsutum* strains.

In *arboreum* and *herbaceum*, varieties possessing a staple length of nearly 1 in. and capable of spinning counts as high as 37 to 42 have been released, notable among *arboreum* being N.14, Gaorani 6 and Virnar, and among *herbaceum*, Jayadhar and Vijaipala. These strains are highly resistant to *Fusarium* wilt and represent the culmination of successful work in this direction.

In *hirsutum* the corresponding values reached are about 1 in. to  $1\frac{3}{16}$  in. for staple and up to 52s for spinnability, the leading varieties being MCU-2, H.14 and 124 Co.2-M. In this species breeding for blackarm resistance is in progress; success has also been achieved in the evolution of jassid resistant types, but the problem of bollworm resistance is yet unsolved.

Work has been carried out, notably at Surat and Coimbatore, on interspecific hybridization. Heterosis in *hirsutum*  $\times$  *barbadense* hybrids is being sought for commercial exploitation. Comprehensive genetical studies have been undertaken on the lines of the replicated progeny-row technique formulated by Hutchinson and Panse.

India is still deficient in cottons of more than 1 in. staple. This, apart from improvement in yield and breeding for resistance to pests and diseases, constitutes one of the most important lines of present and future research. The Indian Central Cotton Committee, formed in 1921, has played an important rôle in the financing and co-ordination of this work. Researches on induced mutagenesis have also been taken up at the Indian Agricultural Research Institute.

**150. Performance of Cambodia Sea Island Cotton Hybrid in Madras State.** N. K. Iyengar and V. Ramaswamy. (*Ind. Cott. Grug. Rev.*, 12, 1, 1958, p. 31.) This paper records the results of a pilot scheme to raise 10 acres of the hybrid on cultivator's holdings in South Malabar. The average yield realized 525 lb. seed cotton per acre, although cultivators who tended the crop well obtained yields up to 917 lb. These yields compare with an average of 876 lb. on the Agricultural Station, where the highest yield realized 1,088 lb. The lint possesses a mean fibre length of 1.25 in., and is capable of spinning 60s. The average net return to cultivators was Rs.151 per acre as compared with a normal return of Rs.40-50 for the area. Extended trials are now under way.

**151. H.14, A New Strain for the Punjab.** A. Singh and L. S. Negi. (*Ind. Cott. Grug. Rev.*, 12, 1, 1958, p. 2.) H.14 is a new improved strain of Punjab American cotton evolved at the Cotton Research Station, Hansi. It is a re-selection from 216F, which until recently was the recommended variety and had largely replaced the short stapled *desi* cotton from Hariana tract. In extensive trials H.14 has outyielded 216F by an average of 1.25 to 1.5 maunds of seed cotton per acre. It gins about 1 $\frac{1}{2}$  per cent. more than 216F and possesses finer and stronger lint. On the average of eight years' results, it has been found to spin 6 counts higher than 216F. The seed cotton has a fluffy and attractive appearance and fetches a premium of up to Rs.2 per maund in the market.

H.14 matures about two weeks earlier than 216F, thereby saving one irrigation and enabling the sowing of a crop like wheat or gram

immediately after the cotton in the same field. A random survey carried out in 1956-57 revealed that 78 per cent. of the fields sown with H.14 were double cropped. The early maturity of H.14 also protects the crop from attack by pink bollworm, which is a serious pest of cotton in Hariana tract.

Although H.14 was officially released for distribution as recently as 1954, it is estimated that during 1957-58 it will cover an area of 1½ lakh acres, i.e. over 50 per cent. of the area under cotton in Hariana tract.

**152. Annual Report of the Director, Technological Laboratory, 1955-56.** (Ind. Cent. Cott. Cttee., Bombay.) The report summarizes the results of spinning and fibre tests on standard Indian cottons, trade varieties, improved strains, and experimental material developed by the State agricultural departments.

### Pakistan

**153.** The Taunsa barrage on the river Indus to the north-west of Multan in West Pakistan has recently been completed at a cost of Rs.170 million. It commands a total cultivable area of 1·2 million acres in the desert districts of Muzaffargarh and Dera Ghazi Khan. Although largely devoted to increasing supplies of staple foods, it is expected that the newly irrigated areas will increase cotton production by 22,000 tons.

### China

**154.** According to a report issued in the monthly review of the International Cotton Advisory Committee, the cotton crop is raised in five regions, namely:

1. The Hwang River basin embracing about 56 per cent. of the national total of 15·5 million acres. Here uneven rainfall is the main problem.

2. The Yangtze River basin which accounts for about 37 per cent. Here again the weather is the main problem.

3. The north-west interior, a relatively small area amounting to only 3 per cent. of the total, but entirely irrigated and giving high yields.

4. The north-eastern zone in the Laocho River valley where only early varieties are grown.

5. The southern region in the provinces of Yunnan, Kwangsi, Kiangsi and Kwangtung, the island of Hainan and the southern parts of the provinces of Kweitchow and Fukien. There the climate is ideal but the acreage is comparatively small.

Production at 6·7 million bales (478 lb. net) in 1956 and 7 million bales in 1955 has practically doubled pre-war output, but this has resulted from increased acreage, the average yield having remained fairly constant. Extensive research schemes are now in operation and there have been substantial improvements in quality. In 1950 the average staple length was 21·9 mm. and in 1955, 26·3 mm. Cotton stapling 25·4 mm. or longer represented 72·3 per cent. of the total crop in 1955 compared with 7·3 per cent. in 1950. The four main varieties grown are DPL.15 and the Stoneville strains 2B, 4 and 5A, which together covered 11·6 million acres in 1956. Experiments with *barbadense* types are being carried out in Sinkiang, where 1,700 acres are devoted to fine staple varieties.

In the February 1958 report of the Japanese Cotton Spinning Industry it is shown that under the first five year plan (1953-57) the Chinese cotton industry made remarkable progress. By the end of the period the

thirty-eight new mills in operation and the twelve under construction represented an expansion in equipment of 80 per cent. for the total period, or an annual growth of 12·5 per cent.

In 1956 yarn production reached 5,600,000 bales (400 lb.) and production of cloth amounted to 177 million pieces (40 yards). This resulted in an improvement in *per capita* supply for the Chinese population of 9·51 metres of cloth as compared with only 4·07 in 1947, while over 200 million square yards were exported to south-east Asian countries.

The initial programme for the second plan (1958-62) sets the target for production in the final year at 8·9 million bales of yarn and 235-260 million pieces of cloth, an increase of 60-80 per cent. for yarn and 43-59 per cent. for cloth over the estimated production in 1957.

It is noted, however, that existing machinery is working to capacity to maintain the present output, and a further increase cannot be obtained without additional equipment. Moreover individual expansion is dependent on the supply of raw material, which is at present limited by the requirements of essential food crops.

### Australia

**155. The Queensland crop, which accounts for all Australian cotton production, has declined in recent years, due to unreliable weather and competition from other crops. Production is being encouraged, but Government authorities are not sure that the crop is feasible. Extension of the guaranteed average price to producers of 14 pence per lb. for seed cotton for five years from January 1, 1959, is expected to encourage purchase of machinery and extension of credit.**

The 1957-58 crop is estimated at 2,000 bales, about 2 per cent. of mill requirements, compared with 3,000 bales in 1956-57 and 1955-56. The area planted to cotton for 1957-58 was estimated at 9,000 acres, which was similar to the acreage planted in 1956-57, but about 2 per cent. below the 1955-56 acreage.

## COTTON IN EUROPE

### Spain

**156. Windel's Reviews give an unofficial estimate of the 1957-58 crop at 161,600 bales (500 lb. gross). About 96 per cent. of the crop is American Upland-type cotton, roughly half of which is grown under irrigation. The balance is Egyptian-type cotton wholly produced under irrigation. The harvest was about 30 per cent. below that of the previous season, the reduction in yield being due not to a corresponding decrease in the planted area, but to adverse growing conditions.**

## GINNING AND GINNORIES

**157. Apparatus for Chain Moistening Cotton Fibre during Ginning.** W. R. Bryant. (U.S. Patent Office, 2,815,536 and 2,815,537. From *Text. Tech. Dig.*, 15, 2, 1958, (675).) A description is given of an apparatus for adding predetermined, accurately controlled moisture to cotton fibres at various stages and stations in their passage through a gin plant.

**158. Effect of High-Density Compression on Spinning Performance.** (*Cott. Td.-J.*, 37, 20/12/1958, p. 1. From *B.C.I.R.A. Summ. Curr. Lit.*, 38, 4, 1958, p. 109.) Trials have been carried out in the United States to determine whether Hi-D cotton (cotton compressed

into high-density bales at the ginnery) will fluff up sufficiently in the mill opening room, without additional machinery, to process satisfactorily. Comparative tests carried out on high-density compressed bales, flat bales and standard ginnery bales showed no significant differences in the processing or quality of the products.

### SOILS, FERTILIZERS AND CULTIVATION

**159. A Visual Aid for Studying Soil Pore Space.** C. K. Martin and W. G. Survant. (*Proc. Soil Sci. Soc. Amer.*, 22, 2, 1958, p. 184.) In the method described a 3 in. core sample of air dry soil in an aluminium cylinder was heated in an oven for 3 hours at 105°C. A sponge was supported about 1 in. from the bottom of a pan of water on a wire grid. About 2 in. of hot water was added to the pan and a cotton wick was arranged to deliver water from the pan to the core through the sponge. The cylinder containing the hot core was placed on the sponge and the assembly left in the oven until the presence of moisture on the top of the core indicated that the capillary pore space had been saturated. The hot, moist core was then immersed slowly in hot paraffin wax to a depth of  $\frac{1}{4}$  in. from the top of the cylinder, and left until saturated to the top with paraffin. After the core had cooled it was removed from the cylinder and the soil was washed out with cold water, leaving the cast for observation.

The method of observing the nature of pore space described in this paper was found useful in studying the modifications of the system of channels produced by roots, earthworms, and other agencies influencing soil permeability. It is suggested that other materials more durable than paraffin wax might prove valuable in studying the non-capillary pore space in soils and contribute towards the development of a better way of visualizing the nature of the system of channels which are so influential in the movement of air and water in soil, and which influence the development and functions of plant root systems in soils.

**160. Soil Fumigants and their Use: A Summary.** G. K. Parris. (*Pla. Dis. Repr.*, 42, 2, 1958, p. 273.) This is a revision of an article written in 1952, when practically the only agricultural fumigants in use were chloropicrin, D-D mixture, ethylene dibromide and methyl bromide. There was then no fumigant available which could be applied to the roots of living plants to reduce or remove nematode infection. Today such remedial treatment is possible with nemagon and with V-C nemacide. Soil sterilization, formerly possible only with the high-priced chloropicrin and methyl bromide, can now be carried out at materially reduced costs with vapam and with mylone. After brief notes on the nature, action and types of soil fumigants, the author deals specifically with the properties and limitations of the commercial preparations now available.

**161. A Fluorescent Mineral Tracer Technique to Determine Fungicide Placement in the Soil Profile.** F. R. Johnson and A. M. Hillis. (*Pla. Dis. Repr.*, 42, 3, 1958, p. 287.) Workers investigating the chemical control of seedling diseases have long been aware that soil fungicide placement in the seed furrow is a critical factor, since many chemicals with the desirable characteristics of stability and good residual qualities are water-insoluble, relatively non-volatile and do not move in the soil. Although a number of fungicides are known to be effective under rigidly controlled conditions, therefore, the limitations of field application equipment have prevented effective control of the causal organisms, through improper placement of the fungicide or inadequate soil treatment.

Radioactive tracers for evaluating placement are expensive and hazardous to use, and the search for another tracer method has led to the discovery of zinc orthosilicate (willemite). This synthetic mineral is relatively inexpensive and fluoresces brightly at low concentrations with a minimum of ultra-violet light. Under some soil conditions concentrations of 50 to 100 p.p.m. fluoresce strongly enough for a cross-section of the soil profile to be photographed.

Synthetic willemite at a 40 per cent. concentration in a fungicide dust was applied to the seed furrow at a rate of 10 lb. per acre. Various furrow attachments were used singly and in combination to determine capacity for placing the fungicide in the zone required for control of cotton seedling damping-off. The synthetic willemite was also used with wettable powder fungicide sprays at the rate of 5 lb. per acre, for evaluation of fungicide placement by different nozzle arrangements and combinations. Cross-sections of the treated soil profiles exposed to ultra-violet light were compared for proper location of the fungicide. On the basis of these comparisons it has been possible to recommend certain practices for utilization of effective soil fungicides and proper application equipment.

The technique employing fluorescent mineral tracers may be expanded to include use with fertilizers, insecticides and other soil chemicals, thereby offering a new method for determining proper placement.

**162. Terraclor—A New Soil Fungicide.** E. G. Hartzfeld. (*Agric. Chem.*, 12, 7, 1957, p. 30. From *Field Crop Abs.*, 11, 2, 1958, p. 140.) It is claimed that damping-off of cotton due to *Rhizoctonia solani* can be controlled by 4.5 lb. per acre of active terraclor (PCNB) applied to the seed and surrounding soil at sowing; but where *Pythium* and *Fusarium* are also involved, other fungicides must be added.

**163. Effect of Manuring on Gaorani Cotton.** V. K. Bederker *et al.* (*Ind. Cott. Grwg. Rev.*, 12, 1, 1958, p. 24.) The results of manurial experiments described show that farmyard manure or town compost at 4 tons per acre significantly increased the yield of Gaorani cotton. Other effects noted were better vegetative growth, more bolls per plant, bigger bolls and earlier maturity. There was no effect on the ginning percentage or the weight of 100 seeds.

Application of ammonium sulphate at 20 lb.<sup>N</sup> per acre had a similar effect on yield and other characters. A combination of artificial and organic manures did not increase yield beyond that to be expected from the effect of the individual components. The data indicate that there is some residual effect from organic manures on the succeeding crop of *rabi jowar*.

**164. Manganese Toxicity and Soil Acidity in Relation to Crinkle Leaf Disease of Cotton.** F. Adams and J. I. Wear. (*Proc. Soil Sci. Soc. Amer.*, 21, 3, 1957, p. 305. From *Rev. App. Myc.*, 37, 4, 1958, p. 237.) A Kalmia fine sandy loam with a pH of 4.5 from a river terrace in Alabama, where crinkle leaf of cotton was severe in June 1956, was investigated in the laboratory and greenhouse at the Alabama Polytechnic Institute, Auburn. An application of  $\text{CaCO}_3$  at 2,000 lb. per acre, or  $\text{Na}_2\text{CO}_3$  at 1,000 lb. per acre, prevented the development of the disorder, whereas a neutral calcium salt was ineffectual. The two carbonates greatly reduced the water-soluble manganese content of the soil.

The use of an apparatus based on the principle of a continually circulating soil solution in conjunction with a cation-exchange resin column maintained high acidity of the soil solution while controlling the amount of manganese and aluminium. By this method the crinkle leaf

symptoms were shown to result from a high level of manganese (11 p.p.m. or more) and may be expected to appear with the development of sufficient acidity in soils with a high potential capacity for the supply of soluble manganese. An adequate liming programme is therefore an essential preventive measure. The natural aluminium level (1 p.p.m.) in the solution, while apparently somewhat detrimental to plant growth, did not affect the occurrence of crinkle leaf.

(Cf. Abstract 34, Vol. 34, of this Review.)

### PESTS AND DISEASES

**165. Central African Federation Cotton Pest Research Scheme, Annual Report 1956-57.** This report covers the initial operations of the Colonial Development and Welfare Scheme implemented in 1956 to investigate the status and control of red bollworm (*Diparopsis castanea*) and stainiers (*Dysdercus* spp.) which are the most serious pests of cotton in the Federation.

At Gatooma, the centre of investigation in Southern Rhodesia, detailed observations on the life cycle of *Diparopsis* showed that the peak period of moth emergence takes place during December and January, and the production of both short-term and long-term or overwintering pupæ renders the pest independent of an alternate host plant. No egg or larval predators were observed, but a subterranean driver ant (*Dorylus conradti*) was shown to be a pupal predator, populations of which, it is thought, might be increased by mulching. The sensitivity of pupæ to changes in climate is being studied in the hope that it might be possible through cultivation to alter the pupal environment sufficiently to affect the period of emergence of a proportion of the moths from long-term pupæ.

In insecticide trials weekly applications (from first bud) of 0.25 lb. endrin in 10 gallons of water per acre gave the best control. Among the results noted was the significant increase in the rate and number of sympodial node production. The control of *Diparopsis* larvæ boring into the terminal growing points and stems at an early stage of plant growth may account for this, although a direct effect of endrin on the plant itself cannot be overlooked. Egg counts were observed to be twice as high on the sprayed plants as on the controls, possibly because the sprayed plants, having the higher sympodial node production, were more attractive to ovipositing moths.

It was noted that endrin treatment afforded good protection to flower buds, with consequent reduced shedding due to bollworm, and progressively lesser protection to small green bolls and open bolls. When the effect of the treatment was measured on final populations of long-term *Diparopsis* pupæ, it was found that populations were as high on sprayed as on unsprayed areas, and the use of late insecticide application to reduce the long-term pupal population is viewed with caution. In the trials carried out so far, interaction of *Diparopsis* populations between treatments make it difficult to assess the true efficiency of the spray, and it is evident that individual plots must in future be sufficiently isolated from each other to prevent reinestation.

Investigations carried out at Makanga Experimental Station showed *Dysdercus intermedius* and *D. fasciatus* to be the most important species of stainiers in Nyasaland. The life cycle of these pests and their rates of development on different hosts are discussed. It is concluded on the

available evidence that since the introduction of the early sowing policy in the Lower River cotton has filled in a gap in the host-plant cycle of *Dysdercus*, but that owing to the influence of other factors the increase of *Dysdercus* on cotton due to this policy may not be considerable. *Phonoctonus nigrofasciatus* is shown to be the only predator of importance. In insecticide trials aldrin gave better results than dieldrin.

Brief notes are given on other pests of cotton.

**166. Pests of the Cotton Plant in Cyprus.** S. Pieris. (*Countryman*, (Cyprus), March 1958.) A brief description is given of the most injurious cotton pests in Cyprus, namely the spiny bollworm (*Earias insulana*), pink bollworm (*Platyedra gossypiella*) and aphid (*Aphis gossypii*). From observations made during recent years it has been noted that the larvae of the pink bollworm are more numerous than those of the spiny bollworm, and that one, two or even more larvae of both bollworms may be found in the same boll. Foremost among the control measures recommended are early planting and the strict observance of the regulations governing uprooting and burning of old plants. Routine dusting with insecticides at the rates quoted is also recommended.

**167. L'Acariose du Cotonnier.** (Cotton Mite.) G. Schmitz. (*Bull. Agric. Congo Belge*, 47, 5, 1956, p. 329.) A description is given of the mite *Hemitarsonemus latus* which causes considerable damage to cotton locally in areas of the Belgian Congo, French Equatorial Africa, British East Africa and the Sudan. The mite breeds on the underside of cotton leaves, and the symptoms of attack are severe leaf tattering which, though rarely fatal to the plant, results in abnormal shedding and reduced yields. A history of its life-cycle is included together with notes on measures of cultural and chemical control.

**168. Control of *Aphis gossypii* on Cotton by Seed Treatment with Systemic Insecticides and Concentrated Sprays.** P. R. Almeida et al. (*Biológico*, S. Paulo, 23, 8, 1957, p. 145. From *Field Crop Abs.*, 11, 2, 1958, p. 124.) Treatment of cotton seed immediately before sowing with the systemic insecticide OMPA applied in activated carbon to slightly wet seed at a concentration of 4 per cent. active principle in relation to the weight of the seed, and with 3911 (or thimet), applied in the same way, at 2 and 4 per cent. active principle, was highly effective in controlling *A. gossypii* on cotton during the first 43 days of plant growth (96-99 per cent. control). These treatments increased cotton yields by 75-77 per cent. over yields with the other treatments tested.

**169. Field Tests with Systemic Insecticides Employed as Seed Treatments.** C. R. Parenica et al. (*J. Econ. Ent.*, 50, 1957, p. 614. From *Field Crop Abs.*, 11, 2, 1958, p. 123.) In trials in Texas, thimet and Bayer 19639 were applied to cotton seed as a dust at a rate of 1 lb. active ingredient per acre. Both insecticides resulted in a significant reduction in thrips (*Frankliniella* sp.) at three weeks after plant emergence. At four weeks after emergence there were no significant differences from untreated controls. The cotyledons of treated seed showed some injury in all trials, but this was not serious. Phytotoxicity in true leaves was noted only where granular thimet was placed in drills closely below the rows of treated cotton seed. There were no differences between the emergence of treated and untreated seed. For controlling cotton fleahopper (*Psallus seriatus*) and overwintered boll weevil (*Anthonomus grandis*), foliage treatment with toxaphene was superior to the seed treatments.

**170. Control of Early-Season Cotton Insects with Systemic Insecticides Employed as Seed Treatments.** C. R. Parenica et al.

(*J. Econ. Ent.*, **50**, 1, 1957, p. 31. From *Rev. App. Ent.*, **46**, Ser. A, 3, 1958, p. 91.) Three seed treatments with systemic insecticides for the protection of cotton against *Franklinella* sp., *Aphis gossypii*, *Psallus seriatus*, overwintered adults of *Anthonomus grandis* and a species of *Liriomyza* were evaluated in field experiments carried out in Texas in 1954 and 1955.

In 1954 the sowing rate was less than desired and am. cyanamid 12009 and am. cyanamid 12008 distributed at 0.56 lb. per acre reduced plant emergence by 39 and 13 per cent. respectively; control of the thrips was effective for 3.5 weeks after plant emergence and partial for a further week. Aphids were controlled for 4.5 weeks, after which the infestation disappeared from the untreated plots.

In 1955 better germinating conditions prevailed and treatments of am. cyanamid 3911 and am. cyanamid 12008 at the rate of 1 lb. per acre did not reduce plant emergence except in the plot where seed treated with 3911 was sown a day before heavy rain. Infestations of *Liriomyza* failed to develop on the cotyledons from treated seed, though 50 per cent. of those untreated were infested. Thrips were controlled for five weeks after plant emergence, infestations approaching those on untreated plants after six weeks. Treatment with 3911 gave similar control of thrips to 5-6 weekly sprays of 0.75-1.5 lb. toxaphene per acre after plant emergence.

When adults of *P. seriatus* and *A. grandis* were caged on the plants at weekly intervals, plant growth caused a progressive loss in the effectiveness of treatment with 1 lb. 3911; field records indicated that it remained effective for four weeks after plant emergence, whereas the toxaphene sprays kept the numbers low for six weeks.

In general, seed treatment resulted in increased plant growth in the first few weeks and in accelerated and increased blooming, and in one test, both seed treatment with 1 lb. 3911 and spraying with toxaphene resulted in increased yields.

**171. Occurrence of the Boll Weevil, *Anthonomus grandis*, in the Big Bend Area of Texas.** O. T. Robertson. (*J. Econ. Ent.*, **50**, 1, 1957, p. 102. From *Rev. App. Ent.*, **46**, Ser. A, 3, 1958, p. 100.) An outbreak of *Anthonomus grandis* on cotton occurred in the Big Bend area of Texas in 1953-55, more than 200 miles west of the cotton-producing areas in which damage is normal and about 100 miles from the nearest infestation in Mexico. The weevil was rare in this district before 1953, when an infestation in early November damaged late bolls. Periodic surveys in 1954 showed practically no infestation until September, when 70-96 per cent. of the squares were punctured in one area and insecticides were applied. In 1955, adults were found from June 7 and punctured squares from June 23, and high proportions of squares were punctured by mid-August in fields in which no insecticide had been used. By September 21 8-100 per cent. of squares in the fields sampled showed egg punctures.

**172. Late-Season Control of the Boll Weevil and the Bollworm with New Insecticides.** C. B. Cowan *et al.* (*J. Econ. Ent.*, **49**, 6, 1956, p. 783. From *Rev. App. Ent.*, **46**, Ser. A, 2, 1958, p. 51.) The results are given of experiments with insecticides applied as dusts or low-volume sprays for the control of late-season infestation of cotton by *Anthonomus grandis* and *Heliothis zea* made in central Texas in 1955.

**173. Control of the Cotton Leaf Roller (*Sylepta derogata*) in Pakistan.** (*Pakistan Cottons*, 2, 4, 1957, p. 86.) The cotton leaf roller appeared in an epidemic form during the years 1953-55 in the Sargodha and Gujarat districts of W. Pakistan. These areas are local to the Delphar forest, which serves as a breeding centre for the pest when

the cotton crop has been harvested and humidity outside the forest is low. At the beginning of summer the insects migrate to the surrounding cotton fields as humidity over the planting areas rises. In 1955 about 37,000 acres of cotton were affected; approximately 10,000 acres suffered a loss of 75 per cent. and the remaining 27,000 acres a loss of 35 per cent.

In 1956 the Department of Plant Protection in conjunction with the Departments of Agriculture and Forests organized a campaign for controlling the pest. Since it was not possible to treat the entire forest area, spraying and dusting operations were confined to cross strips through the forest and a strip of about one mile wide round the forest boundary. Treatment began on May 15 and was continued to September 15. About 335 hand operated machines and 16 power driven machines were employed, and approximately 21,000 acres of cotton and 640 acres of forest were treated. Unfortunately the weather was particularly unfavourable and frequent heavy showers greatly reduced the effectiveness of the insecticide, thereby necessitating many more treatments than would normally have been required. Results showed that crops within a radius of 10 miles of the Delphar forest, which had previously carried average populations of 800,000 larvæ per acre, remained almost free of infestation.

**174. *Tarache nitidula*, a Semilooper Pest on Cotton in South India.** S. Venugopal. (*J. Bombay Nat. Hist. Soc.*, **54**, 1, 1956, p. 207. From *Rev. App. Ent.*, **46**, Ser. A, 4, 1958, p. 137.) *Tarache nitidula*, which is widely distributed on the plains of southern India, causes serious injury to cotton in some years. The economic importance and food plants of this Noctuid are briefly reviewed from the literature, all stages are briefly described, and an account is given of observations made during a severe infestation at Coimbatore in 1955. Pairing occurred one day after emergence. The females laid 30-40 eggs singly on the leaves, and the larvæ hatched in 3-4 days, fed on the young leaves and pupated in the soil. The larval and pupal stages lasted 20-22 and 10-12 days, respectively, in July-August. In tests of sprays for control, 0.1 per cent. BHC, aldrin and dieldrin gave 100, 60 and 63 per cent. mortality of larvæ, respectively, in 48 hours; DDT was less effective.

**175. Chemical Control of the Brown Cotton Leafworm, *Acontia dacia*.** E. P. Lloyd and D. F. Martin (*J. Econ. Ent.*, **49**, 6, 1956, p. 764. From *Rev. App. Ent.*, **46**, Ser. A, 2, 1958, p. 49.) Early in 1955 heavy infestations of *Acontia dacia* developed on cotton in Texas. The results are given of tests carried out with various insecticides.

**176. The Omnivorous Leaf Roller, *Platynota stultana*, on Cotton in Southern California.** E. L. Atkins et al. (*J. Econ. Ent.*, **50**, 1, 1957, p. 59. From *Rev. App. Ent.*, **46**, Ser. A, 3, 1958, p. 95.) In 1954 larvæ of *Platynota stultana* feeding on the leaves, terminals, squares and bolls of cotton caused serious damage and loss of yield in areas of California. High populations were maintained throughout the year on a succession of plants, and control was difficult because the larvæ concealed themselves in nests of webbing between plant parts, or in rolled leaves, and other stages in the life-cycle, which varies considerably in length, were resistant to insecticides. Moreover, owing to the high temperatures prevailing in the area the insecticide residues soon lost their strength.

Results are given of tests with 27 insecticides which were used as control measures.

**177. The Effect of Pink Bollworm Infestations on Yield and Quality of Cotton.** J. R. Brazzel and J. C. Gaines. (*J. Econ. Ent.*,

49, 6, 1956, p. 852. From *Rev. App. Ent.*, 46, Ser. A, 2, 1958, p. 57.) Experiments were carried out in Texas in 1955 to compare the losses in cotton quality and yield resulting from various levels of infestation by *Platyedra gossypiella* in the absence of other pests. Plots measuring 24 square yards and containing cotton plants from which all squares had been picked were sprayed to destroy any insects present and covered with cages on June 4; 2, 6 or 15 adults of *P. gossypiella* of both sexes were released on them on June 18 and 24 and July 2, and infestation records were taken at intervals of 5-7 days from June 30 until August 1, when practically all the bolls were infested and the numbers of larvæ per boll averaged 6.4, 9.6 and 12.9 respectively. The plants were defoliated chemically on August 6 and the cotton harvested on August 22, and examination of lint and seed showed that all levels of infestation reduced both quality and yield; at the two lower levels, losses were mainly due to reduction in quality, whereas at the highest they were due mostly to reduction in yield. It is pointed out, however, that the levels of infestation tested were much higher than would normally occur in the field.

**178. The Biology of the Sudan Bollworm, *Diparopsis watersi*, in the Gash Delta, Sudan.** J. P. Tunstall. (*Bull. Ent. Res.*, 49, 1, 1958, p. 1.) This paper is concerned with certain aspects of the biology of *Diparopsis watersi*, a serious pest of the cotton crop in the Gash Delta in Eastern Sudan, which were studied over the period 1951-55. The climate and method of cotton cultivation are described briefly and a general account of the incidence of the pest is included. Its egg-laying and larval habits and the duration of the pupal stage are reported in detail. The pattern of moth emergence from diapause pupæ in the Gash Delta is compared with that found in Nigeria and Nyasaland. Natural mortality of *D. watersi* is discussed, and certain larval parasites, notably an un-named species of *Apanteles* and *Bracon brevicornis*, are considered to be important.

The study emphasizes the difficulties in controlling this bollworm, and stresses the importance of attempting to destroy it in the diapause state, preferably during the "dead" season. It is considered that mechanical cultivation of the soil may provide a means to this end.

**179. Factors Affecting the Toxicity of Insecticides to Cotton Pests.** W. J. Mistric and D. F. Martin. (*J. Econ. Ent.*, 49, 6, 1956, p. 757. From *Rev. App. Ent.*, 46, Ser. A, 2, 1958, p. 48.) Results are given of investigations carried out at College Station, Texas, in 1954 on the effects of climatic factors on the toxicity of certain insecticides to adults of *Anthonomus grandis* and larvæ of *Alabama argillacea* on cotton.

**180. Effect of Climatic Conditions on the Chemical Control of *Tetranychus* spp. and *Aphis gossypii* on Cotton.** W. J. Mistric and D. F. Martin. (*J. Econ. Ent.*, 49, 6, 1956, p. 760. From *Rev. App. Ent.*, 46, Ser. A, 2, 1958, p. 48.) Investigations carried out at College Station, Texas, in 1954 on the effect of weather on the toxicity of parathion and aramite to *Tetranychus desertorum* and *T. telarius*, and of parathion and BHC to *Aphis gossypii* on cotton seedlings treated with emulsion sprays at 7.5 U.S. gals. per acre, showed that the Aphid was more effectively controlled with 0.25 lb. parathion or 1.2 lb. BHC per acre at a temperature of 94° F. than at 70° or 107°. BHC was ineffective one day after application at all three temperatures, but parathion showed appreciable residual toxicity for three days at the two higher temperatures. The persistent effect of parathion on the mites was similar to that on the Aphid, but the effect of aramite decreased considerably after a day, especially against *T. desertorum*. Exposure to dew, rain, wind, high

temperature or sunlight had generally less effect on BHC and aramite than on parathion.

**181. Reduction in Yield of Cotton in the United States Caused by Diseases in 1957.** Compiled by the Cotton Disease Council, U.S.A. (*Pla. Dis. Repr.*, **42**, 2, 1958, p. 169.) The 1957 Cotton Disease Loss Estimate is the sixth annual summary submitted by the committee on cotton disease losses. In general, estimates have been drawn from the same sources through this period, and as methods and techniques are becoming progressively uniform, the committee feels that considerable reliability can now be placed in the report.

Estimates are given of losses due to the nine major cotton diseases for each cotton producing State. The 1957 total percentage loss of 12 per cent., representing over 1,588,200 bales, shows an increase over the percentage loss of 10·65 per cent., representing over 1,569,000 bales, in 1956. As in 1956, seedling diseases (*Rhizopus*, etc.) caused the greatest loss, 322,700 bales; the next in importance were boll rots (*Rhizopus*, etc.), 275,900 bales; *Vorticillium* wilt (*V. albo-atrum*), 239,742 bales; bacterial blight (*Xanthomonas malvacearum*), 233,000 bales; and *Fusarium* wilt (*F. vasinfectum*), 148,700 bales. Losses were outstandingly high in Missouri, 32·6 per cent. and lowest in Oklahoma, 7·6 per cent.

**182. Anthracnose of Cotton in Khandesh.** Y. S. Kulkarni *et al.* (*Ind. Cott. Grwg. Rev.*, **12**, 1, 1958, p. 34.) In wet seasons through the past twenty years cotton in Khandesh has suffered serious damage from seedling blight and boll rot caused by anthracnose (*Colletotrichum indicum*). The control measures recommended include the dressing of seed with mercurial compound at the rate of 2 oz. to 15 lb. of seed, careful thinning, and two to three sprayings with a copper compound during the month of heaviest rainfall. In addition it is essential that two or three year rotations should be followed to avoid secondary infection from debris lying in the field.

**183. Infection Studies with the Cotton Rust Pathogen, *Puccinia stakmanii*.** B. B. Berkenkamp and R. B. Streets. (*Phytopathology*, **47**, 9, 1957, p. 516. From *Rev. App. Myc.*, **37**, 2, 1958, p. 85.) Teleutospores of *P. stakmanii* germinate only when thoroughly wet, and then within 7 hours at room temperature. Pycnia appear in the field in 4 days and accidia in 14 days after rain; 24-hour high R.H. suffices for infection, wet leaves being found less susceptible than dry. Natural occurrence is erratic. A parasite of the accidia is probably *Tuberculina persicina*.

**184. Effect of Various Seed Treatments on the Control of Cotton Seedling Diseases.** J. S. Hsu and T. H. Chien. (*Acta. Phytopath. Sinica*, **2**, 2, 1956, p. 115. In Chinese with English abstract. From *Rev. App. Myc.*, **37**, 3, 1958, p. 168.) At Nanking Agriculture College during 1953-55 two methods of hot water treatment used for the control of cotton seedling diseases, 55°-60° C. for 30 minutes and 74° for 30 minutes, both proved effective, particularly if followed by fungicidal treatment. Dusting with 0·5 per cent. ceresan or 0·2 per cent. granosan reduced diseased seedlings by 37-78 per cent. compared with the control, but 0·5 per cent. uspulun was not effective. Covering seeds at sowing with a mixture of cotton seed meal and field soil in which strains 6 and 28 of *Actinomyces* (*Streptomyces*) were cultured gave some 50 per cent. control of seedling diseases.

**185. The Effect of Seed Treatment of Cotton with Thimet, a Systemic Insecticide, on *Rhizoctonia* and *Pythium* Seedling Diseases.** D. C. Erwin and H. T. Reynolds. (*Pla. Dis. Repr.*, **42**, 2, 1958, p. 174.) Treatment of cotton seed with thimet 44D, a systemic insecticide,

following treatment with one of the mercurial fungicides, ceresan 200, ceresan M-2X, or panogen, under certain environmental conditions has resulted in poor plant stands in the San Joaquin valley of California. In greenhouse tests neither delay in germination nor decrease in percentage of germination was apparent when cotton seeds treated with thimet or with thimet in addition to ceresan 200 were planted in steamed soil. In soil infested with *Rhizoctonia solani*, thimet as a seed treatment increased the percentage of emergence and appeared to be fungitoxic, a property not previously recognized for this compound. In soil infested with *Pythium debaryanum*, thimet did not increase the percentage of emergence. In non-sterilized soil containing both a *Pythium* sp. and *Rhizoctonia solani*, the percentage of emergence of cotton seed treated with both ceresan 200 and thimet was much less than from seed treated with ceresan 200 alone. Treatment of seed with a thimet-captan mixture or with thimet following an initial seed treatment with captan has induced a satisfactory stand of cotton in non-sterilized soil.

**186. Damping-off of Cotton Seedlings Caused by *Colletotrichum hibisci*.** H. G. Pulsifer. (*Iowa St. Coll. J. Sci.*, 32, 1, 1957, p. 57. From *Rev. App. Myc.*, 37, 3, 1958, p. 169.) At the Agricultural Experiment Station, Ames, Iowa, isolates of *C. hibisci* from kenaf (*Hibiscus cannabinus*) caused a damping-off of cotton seedlings comparable with that caused by *C. (Glomerella) gossypii*, but spraying seedlings with conidial suspensions did not produce infection in the mature plants. The conditions of the experiment, however, were unfavourable to boll infection. One instance of limited infection of kenaf seedlings by an isolate of *C. gossypii* was observed.

**187. Classification of Some Cotton Strains According to their Degree of Resistance to Wilt.** M. K. Desai. (*Ind. Cott. Grwg. Rev.*, 12, 2, 1958, p. 88.) During the course of breeding *Fusarium* wilt resistant strains of *herbaceum* cottons, it was noted (1) that different strains or groups of strains manifested differences in the incubation period and in the sequence of deaths thereafter, and (2) that each strain showed uniform reaction vouchsafing its homozygosity. Under greenhouse conditions, although both Dharwar No. 1 and Jayawant wilted 100 per cent., wilting in the case of the former commenced on the eleventh day from sowing and ceased within 30 to 35 days, whereas with Jayawant it had barely started on the fourteenth day and took 40 days or longer to kill the plants completely. Wagale, Shan and Comilla 4-2 formed a class by themselves, in that they broke down promptly and completely within the shortest time without manifesting even the symptoms. They began to wilt on the eighth to tenth day from sowing, were in the flush of wilt from eleventh to thirteenth day and were all wiped out within 3 days thereafter. Kumpta Farm T.14 carried the highest degree of resistance and suffered no deaths.

A summarized analysis of incubation period and sequence of death enabled groups of strains to be classified into clear-cut categories according to their degree of resistance.

**188. Influence of *Fusarium* Culture Filtrates on Respiratory Changes in Cotton.** M. Lakshmanan and C. S. Venkata Ram. (*Proc. Ind. Acad. Sci., Sect. B*, 46, 2, 1957, p. 131. From *Rev. App. Myc.*, 37, 3, 1958, p. 168.) Of culture filtrates from twenty-one *Fusarium* spp. examined at the University Botany Laboratory, Madras, thirteen caused considerable increases of tissue respiration in cotton stem sections, three caused slight increases, and four were inhibitory. Various organic acids,

growth substances, amino acids and vitamins in the filtrates stimulated respiration when tested individually.

**189. Biological Control of *Verticillium* Wilt of Cotton.** S. Y. Yin et al. (*Acta. Phytopath. Sinica*, 3, 1, 1957, p. 66. Chinese with English Abs. From *Rev. App. Myc.*, 37, 3, 1958, p. 168.) At the Liaoyang Cotton Experimental Station antagonistic actinomycetes cultured on cotton seed cake used as fertilizer stimulated the growth of cotton plants and decreased *Verticillium* wilt. Isolates G4 and 5406 gave the best results; three applications of the fertilizer containing them resulted in a decrease of 31-50 per cent. in the disease and an increase of 14-40 per cent. in yield. A fourth application was not economic. Slide burial tests showed that the actinomycete isolates survived longer at soil depths of 2.5-10 cm., but their amount was gradually reduced with time; they were most abundant at 5.7.5 cm.

#### GENERAL BOTANY, BREEDING, ETC.

**190. The Cytology of Two Hybrids of *Gossypium*.** J. E. Endrizzi. (*J. Hered.*, 48, 1957, p. 221. From *Pla. Bree. Abs.*, 28, 2, 1958, p. 327.) Some morphological characters of the  $F_1$  hybrids of *G. hirsutum* with *G. aridum* and *G. lobatum* were compared with those of the parents; details of chromosome pairing in the hybrids are reported. *G. hirsutum* has the A and D genomes and the two diploids have the D genome; it is thought that *G. lobatum* should be placed in a genome category of its own, D<sub>7</sub>. Pairing of A and D chromosomes in the trivalents is considered to be due to residual homology; chiasma seemed to occur in the terminal regions of the chromosome arms.

**191. Segregation in New Allopolyploids of *Gossypium*. II.—Tetraploid Combinations.** D. U. Gerstel and L. L. Phillips. (*Genetics*, 42, 6, 1957, p. 783.) In other papers in this series the segregation of artificial hexaploid combinations was described. These had been obtained by crossing tetraploid New World cottons with diploid wild American species and subsequent doubling of the chromosome number. For certain characters these hexaploids were of duplex genotype. The present paper deals with allotetraploids synthesized from various diploid members of the genus. These were either taken from the same section, as in the cases of 4n (*G. arboreum*  $\times$  *herbaceum*) and 4n (*G. thurberi*  $\times$  *amondii*), or from different sections, as in 4n (*G. arboreum*  $\times$  *anomalum*) and 4n (*G. arboreum*  $\times$  *thurberi*). Genetical segregation ratios were found to widen rapidly with decreasing cytotoxic affinity of the component species. In several instances it was possible to compare the segregation ratios for factors located on different chromosomes.

**192. Interaction of Genes for Round Leaf and Frego Bract in Cotton.** C. F. Lewis. (*J. Hered.*, 48, 1957, p. 169. From *Pla. Bree. Abs.*, 28, 2, 1958, p. 325.) The mutant genes, *rl* determining round leaf and *fg* frego bract, were found to act as recessives when studied separately or when heterozygous in the same plant. When a plant is homozygous for round leaf and heterozygous for frego bract the smaller bract associated with *rl* may be narrowed and twisted to show the frego bract phenotype. This is interpreted as a loss of dominance in *Fg* in a genetic background homozygous for *rl*.

**193. Inheritance of a New Dwarf Mutant in *G. arboreum*.** N. K. Iyengar et al. (*Ind. Cott. Grwg. Rev.*, 12, 1, 1958, p. 10.) The inheritance of a dwarf mutant discovered in an *indicum*  $\times$  *cernuum* hybrid derivative in

*G. arboreum* and designated as "1016 dwarf" is reported in this paper. In crosses with normal varieties, K.1, C. G. Hills, NR.5 and NM Dollar, it behaved as a monogenic recessive, while it was complementary to Anakapalle dwarf ( $d_1$ ). The behaviour in the cross with Cocanadas dwarf ( $d_2$ ) indicated homology between the two dwarfs. Plant habit and leaf shape, and plant habit and corolla colour, assort independently.

**194. Origin and Inheritance of  $D_2$  Smoothness in Upland Cotton.** J. R. Meyer. (*J. Hered.*, **48**, 1957, p. 249. From *Pla. Bree. Abs.*, **28**, 2, 1958, p. 327.) It was found that  $D_2$  smoothness is due to a single dominant gene *Sm*, which has been transferred from a wild American species, *G. armourianum*, to Upland cotton; *Sm* is in the D sub-genome.

**195. Estimates of Genotypic and Environmental Variances and Covariances in Upland Cotton and their Implications in Selection.**

P. A. Miller *et al.* (*Agronomy J.*, **50**, 3, 1958, p. 126.) Ten characters in each of three populations of  $F_4$  and  $F_5$  lines of Upland cotton were studied. Two of the populations were grown at the same two locations in each of two years, the third population being grown in two years at a single different location each year. Estimates were obtained of the genetic, environmental and genotypic  $\times$  environmental interaction variances and covariances for all traits.

Environmental variances as measured by the plot error were generally large for lint yield, bolls per plant, seed per boll, and boll weight; and small for lint percentage, seed and lint index, and fibre length, strength and fineness. The magnitudes of the genotype  $\times$  environment interaction components were generally small in relation to the size of the corresponding genetic components for most of the traits, although the line  $\times$  location  $\times$  year interaction component for lint yield and bolls per plant in one population was of sufficient magnitude to be important from the breeding viewpoint. Sufficient genetic variability appeared to be present in all populations to enable substantial genetic advance through selection for each of the traits studied.

Genotypic and phenotypic correlations among the ten traits were calculated. In all populations lint yield was highly positively correlated with lint percentage and bolls per plant negatively correlated with seed index and weight per boll.

With the information furnished by the variance and covariance relationships, several selection indices for lint yield were constructed and evaluated.

Implications of the effect of variance and covariance estimates on selection and breeding procedures are discussed.

**196. Inheritance of Fibre Density in a Hybrid between Upland and Sea Island Cotton.** M. R. Limaye. (*Diss. Abstr.*, **17**, 1957, p. 470. From *Pla. Bree. Abs.*, **28**, 2, 1958, p. 328.) The inheritance of seed index, lint-density index, lint index and lint percentage was investigated in three crosses of Upland with Sea Island cotton. High seed and high lint indexes were dominant. A considerable degree of hybrid vigour was expressed in respect of seed index, with the main consequence of a higher mean lint index in the  $F_1$ . Dominance did not affect lint-density index. In two crosses low lint percentage was partially dominant. Except in the case of lint index, no transgressive segregation was detected. Although inherited in a typically quantitative manner, seed and lint-density indexes appeared to depend upon relatively few genes. Heritability values for all the characters studied were relatively high, the value for lint percentage being of the greatest magnitude. Seed and lint-density indexes were not

associated. Highly significant positive associations were found between lint-density index, lint index and lint percentage. Seed index was negatively correlated with lint percentage, but the association was not high as the result of the influence of lint-density index. Seed and lint indexes were positively correlated. The association between lint index and lint percentage was positive and complete when seed index was held constant, but was negative with lint-density index as a constant.

**197. Breeding Tanguis Cotton, Season 1955-56.** E. D. Mendez. (*Inf. Mens. Estac. Exp. Agric. La Molina*, **31**, 360, 1957, p. 8. From *Pla. Bree. Abs.*, **28**, 2, 1958, p. 329.) The best lint yields of the season were those of lines LMW1877-50, LM1041-49, SNA251 and SNA28WT, between which there was no significant difference. LMW lines exhibited resistance to wilt (*Verticillium albo-atrum*) and lower yield losses from disease. Among the progeny of selections made on the basis of resistance to wilt or root rot (*Thielaviopsis basicola*), or both, LWMI-52-55 and LMWII-52-55 showed promise. Seventeen plants of the line LM1041-49, which were not attacked by nematodes, are to be studied in the coming year.

**198. Water Absorption, Hygroscopic Equilibria and Respiratory Activity in Seeds of "Moco" Cotton (*G. hirsutum* var. *mariegalante*).**

M. M. Ventura, (*Phyton*, **7**, 1, 1956, p. 7. English abstract. From *Field Crop Abs.*, **11**, 1, 1958, p. 48.) The penetration of water into cotton seeds was studied by immersing them in solutions of sodium chloride giving different osmotic pressures. A table shows the percentage increases in weight after 3-24 hr. The penetration of water into the seed was found to take place initially almost exclusively through the chalaza. The effect of the relative humidity of a static atmosphere (15-95 per cent.) on the moisture absorption of intact seeds was investigated; equilibrium was reached after 20-25 days.

**199. The Influence of Progressive Increases in Total Soil Moisture Stress on Transpiration, Growth, and Internal Water Relationships of Plants.** R. O. Slatyer. (*Aust. J. Biol. Sci.*, **10**, 3, 1957, p. 320. From *Field Crop Abs.*, **11**, 1, 1958, p. 48.) The response of cotton (*G. barbadense*) to conditions of increasing total soil-moisture stress were measured in terms of vegetative growth, stem elongation, transpiration, leaf turgor, diffusion pressure deficit and osmotic pressure. The response pattern showed a close relationship to water stress, and in each species growth (as total dry weight) did not continue beyond a stress value such that there was zero turgor pressure in the tissue of adult leaves. Stem elongation also ceased at this value. Permanent wilting was associated with the point of zero turgor pressure and occurred at a soil-water content of 10.2 per cent.

**200. Absorption of Sulphur Dioxide from the Atmosphere by Cotton Plants.** R. A. Olsen. (*Soil Sci.*, **84**, 2, 1957, p. 107. From *Field Crop Abs.*, **11**, 1, 1958, p. 49.) Cotton seedlings were grown in nutrient solutions containing 0.1, 2, 5, 10 and 50 p.p.m. sulphate as sodium sulphate. Concentrations of 0.1 p.p.m. caused chlorosis and very little growth was made. Increments up to 10 p.p.m. sulphate resulted in marked increases in growth and reductions in chlorosis. Plants grown in 10 p.p.m. concentrations grew rapidly and were dark green; higher concentrations of sulphate did not result in increased growth. Atmospheric sulphur dioxide (ranging from 0.01 to 0.05 p.p.m. by volume) was readily absorbed by the plants, the amount absorbed being roughly proportional to the leaf area. Healthy plants obtained about 30 per cent. of their total sulphur from the atmosphere; in chlorotic

plants, about 50 per cent. of their sulphur came from the air. The presence of sulphur dioxide in the air used to aerate the nutrient solutions in which the plants grew did not affect their growth or sulphur content.

**201. Preliminary Experiments Employing Gibberellic Acid as a Cottonseed Treatment.** D. R. Ergle and L. S. Bird. (*Pla. Dis. Rept.*, **42**, 3, 1958, p. 320.) Gibberellic acid (GA) has been shown to induce multiple growth and physiological responses in cotton. The observation that GA increased stem elongation of young cotton plants suggested that its application to the seed might hasten seedling emergence or subsequent seedling growth, thereby enabling the plants to escape some of the damage due to seedling diseases.

In preliminary greenhouse experiments 25 gm. lots of undelinted seed (Empire WR) were treated with 10 mgm. of GA with 1 gm. of carbon powder, and similar quantities of acid delinted seed were soaked for 5 minutes in 50 ml. of a 2.5 per cent. aqueous solution of methyl cellulose containing 10 mg. of GA, and allowed to become air dry before planting. Results with seed planted in sand showed no effect of GA on germination or time of emergence, but an increase in seedling height and stem dry weight. GA appeared to inhibit growth of seed planted in loam.

In field experiments the seed was treated with 0, 45, 90 or 180 mg. of GA per 225 gm. of acid delinted seed, using methyl cellulose as a sticking agent. Heavy rainfall and resulting compaction of the soil after planting led to poor stands of both treated and untreated seed, the basic cause of which seemed to be not the applied GA but the inherent mechanical weakness of the hypocotyl. During the movement of the hypocotyl upward, with the cotyledons trapped by the packed soil, the hypocotyl broke in the crook region, leaving the seedling without cotyledons and incapable of further growth. Presumably the action of GA by accelerating cell elongation without a corresponding increase in thickness further weakened the hypocotyl. Moreover, although high concentrations of GA may be inhibitory but not necessarily toxic, even the lowest rate used in the field tests, 45 mg./225 gm. seed, may have been excessive. A comparable rate had no effect on emergence and stimulated early growth of seed sown in sand in the greenhouse, but not of seed sown in loam. Additional information is needed on the influence of application rate and on the interrelations of GA with soil type, temperature and moisture in order to evaluate the use of GA as a cottonseed treatment.

**202. Compositional and Physiological Responses of the Cotton Plant to the Systemic Insecticides Schradan and Demeton.** J. Hacksaylo and D. R. Ergle. (*Texas Agric. Exp. Sta. Bull.* **821**, 1955. From *Field Crop Abs.*, **11**, 2, 1958, p. 124.) Cotton plants grown in culture solutions containing schradan accumulated insecticide in successively lower concentrations in leaves, roots, bolls, petioles and stems. Schradan concentrations of 10 p.p.m. stimulated vegetative development. Concentration of 100 p.p.m. and over were phytotoxic to vegetative and fruiting activity. When concentrations of nitrogen or phosphorus (but not potassium) in the culture solution were reduced, schradan accumulated in the plant to a greater extent. Seed from schradan-treated plants contained more protein and less oil than normal; demeton produced the reverse effect. As the schradan concentration in the solution increased, soluble nitrogen in the plant increased, but there was no effect on protein level. High levels of schradan application caused a decrease in total sugars, and increased starch production in the roots only.

## CURRENT NOTES

We have great pleasure in recording the award of the O.B.E. to Mr. H. E. King, the Corporation's senior officer in Northern Nigeria.

Professor G. E. Blackman, who is a member of the Corporation's Panel of Scientific Consultants, will visit the Namulunge Research Station, Uganda, from July 8 to 15, on his way to the African Weed Control Conference at Victoria Falls, which has been arranged by Fison's Pest Control Ltd.

Mr. J. C. May, C.M.G., O.B.E., Director of the Corporation, and Mr. D. F. Ruston, Secretary, attended meetings of the International Cotton Advisory Committee held in London through the first week in June.

Dr. G. M. Wickens visited the Lake Province of Tanganyika in March in connection with outbreaks of *Fusarium* wilt disease there.

Mr. M. A. Choyce attended the Overseas Agricultural Officers' Course held at Chesterford Park, Essex, from June 16 to 27.

In April Mr. R. C. Faulkner of the Namulunge Station, Uganda, transferred to Wad Medani, Sudan. Mr. L. C. Hughes of the Sudan will transfer to Namulunge in October.

The following appointments have been made to the overseas staff: Mr. F. H. Alston and Mr. N. L. Innes as plant breeders to the Namulunge Station and the Sudan, respectively; Dr. M. Dransfield and Mr. D. A. Perry as plant pathologists to the Sudan and East Africa respectively; Mr. W. Reed and Mr. D. M. Robinson as entomologists to Nigeria and Namulunge, respectively.

Studentships in plant breeding, tenable at Cambridge in 1958-59, have been awarded to Mr. B. E. Costelloe and Mr. D. A. Morris.

The following members of the staff are now on leave or will shortly be arriving in the U.K., and will be returning to their stations on or about the dates shown:

Mr. J. E. A. Ogborn	Aden	July 14
Mr. M. A. Choyce	Nigeria	July 19
Dr. J. E. Dale	Uganda	July 26
Mr. J. H. Saunders	Sudan	August 2
Mr. J. H. Davies	Uganda	August 10
Mr. J. R. Spence	West Indies	Mid August
Mr. K. R. M. Anthony	Aden	August 21
Mr. H. E. King	Nigeria	August 30
Mr. M. H. Arnold	Tanganyika	September 8
Mr. B. J. S. Lee	Nigeria	Mid September
Mr. M. S. Hastie	Kenya	Mid September
Dr. S. O. S. Dark	Sudan	September 21
Mr. L. C. Hughes	Uganda	October 5
Mr. R. C. Faulkner	Sudan	October 22
Dr. G. M. Wickens	Uganda	end October
Mr. H. G. Farbrother	Uganda	November 26

Mr. Allan Fish, who was for many years secretary of the Cotton Research Station, first at Barberton, South Africa, and subsequently at Namulunge, has resigned his appointment with Sukulu Mines Ltd., and has acquired from South Coast Hotels Ltd., the Diani Beach Hotel. Mr. Fish and his wife have taken up permanent residence at the hotel, which is situated on the coast about 20 miles south of Mombasa, and they will be pleased to supply further information on application to Diani Beach Hotel, P.O. Ükunda, via Mombasa, Kenya.

# EMPIRE COTTON GROWING REVIEW

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Vol. XXXV

OCTOBER 1958

No. 4

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## THE OBJECTIVES OF RESEARCH IN TROPICAL AGRICULTURE\*

SIR JOSEPH HUTCHINSON, C.M.G., Sc.D., F.R.S.

I HAVE chosen the objectives of research as the topic of my address partly because I think you may be interested in the changes that have taken place in those objectives during the past sixty years, but mainly because, since you have done me the honour to invite me to give you something of a farewell address, I cannot resist the temptation to air my own views.

The agricultural services of the British Commonwealth overseas had their beginnings in the two Imperial Departments that were set up about the turn of the century, and the first piece of history I should like to bring to your notice is the fundamental difference in approach between the Imperial Department of Agriculture in the West Indies and the Imperial Department of Agriculture in India. The Imperial Department in the West Indies was set up under Dr. (later Sir Daniel) Morris, a scientist by training and outlook. Under him the Department, though always short of money and staff and though constantly losing its good men to the sister Department in India, set a standard of investigation and advice that has provided the basis of the current agricultural systems of the region, and the foundations of the present Imperial College of Tropical Agriculture. By contrast, in India it was felt that the new Department should be headed by senior Indian Civil Service men with a reputation for their interest in the peasant, and staffed by young science graduates without the experience necessary for senior posts. These excellent and public spirited I.C.S. men, having no scientific training, judged the work of their subordinates by the sole criterion they understood, which was its immediate applicability to the improvement of Indian farming. So the long view, the pursuit of knowledge with only an incidental interest in its application, was discouraged. Life was short and the peasant was poor, and something must be done for him by the middle of next week. So it was in the West Indies that the breeding of sugar cane from seed was worked out, and Barber took the technique from there to Coimbatore in South India. In the West Indies the potentialities of better crushing

\* Address given by Sir Joseph Hutchinson to the Uganda Agricultural Association Annual Meeting, September 1957, prior to his retirement from the post of Director of the Cotton Research Station, Namulunge, in order to take up his appointment as Drapers Professor of Agriculture at Cambridge University.

trains and vacuum pan crystallisation were demonstrated, and adopted in the sugar industry. And it was from the West Indies that men like Le Froy and Howard and Burt went to India.

When I went to India in 1933, the contrast in the state of agricultural science in the two regions was quite remarkable. In the West Indies the sugar industry, bedevilled by politics and the tariff arrangements associated therewith, was still alive and active thirty-odd years after its obituary had been written by a Royal Commission. Practice in the factory and in the field had changed out of all recognition under the stimulus of men like Sir Francis Watts and G. A. Jones. Not only so, but the Sea Island cotton industry had been established and the various hazards to which it is subject—insect pests, bacterial blight and varietal degeneration—had been overcome with scientific enterprise and imagination. In this atmosphere of investigation and experiment the Imperial Department had given place to the Imperial College of Tropical Agriculture, bequeathing to it a rich tradition, its library, and a number of its able and experienced staff. The achievements of the past and the promise for the future had been such that after an intensive study of alternative possibilities, the Empire Cotton Growing Corporation had decided that the proper site for their long range cotton research station was beside the Imperial College in Trinidad.

In India, on the other hand, we had a feeling of frustration. The straightforward things had been done. The help that could be given to the cultivator on the knowledge then available had all been offered. What remained was to multiply the improved varieties, breed for disease resistance and control bollworms and make compost. The whole machine had run down for lack of the long view. It was not that no long range work had been done. Martin Leake, for instance, did pioneer work on the genetics of the Indian cottons. But long range work was against the grain, and received no encouragement. And men like Martin Leake were given more urgent jobs to do, such as administering an Agricultural College, and their work remained unpublished. The whole attitude in India was summed up by Barber's preface to his lectures to us on Tropical Agriculture at Cambridge. We should be well advised, he told us, to refrain from making suggestions for the improvement of the peasant's cultivation practices. He had been doing it for several thousand years, and understood these things a lot better than we ever should. India has moved far from that state of mind in the past twenty years, of course, but it certainly held the field in the early '30s.

I am enormously grateful for my West Indian heritage. Let us be fair to those who worked in India in the early days. They were concerned with a long established, stable agricultural economy. The most important thing was to make the country safe from famine, and then things might be expected to run fairly smoothly. There was no urgent call to do something different. The Imperial Department in the West Indies, on the other hand, had the spur of agricultural bankruptcy. The Department was set up because the plantation system was down and out, and there was no question of doing the same old thing, but doing it a

little better. They *had* to look for something new. And looking for something new is a great way of stumbling on new ideas.

It is so easy to forget that the agricultural practices that we regard as day to day matters were the result of the long range thinking of men who were the contemporaries of our fathers. Who today would regard a close season for cotton as anything but agricultural ABC? Yet the close season was Ballou's answer to the leaf blister mite at a time when the annual *versus* perennial cotton controversy was still unsettled. That settled it, of course, but Ballou had to think far enough not only to say "you must uproot by the scheduled date," but also "you must accept varieties short enough term to be uprooted by that date *and you must grow no other.*" We say, "of course," but that wasn't what the West Indian planters said. We forget these things, and in forgetting them we overlook the corollary that the day to day progress of our sons' generation will depend on the long range thinking, planning and experimentation that we do in our day.

I am well aware of the force of the argument that we need to concentrate on improvement now. What I will not admit is that we therefore have no time to spare for consideration of less immediate interests. I am by training a "pure" research worker, and I learnt my trade in the days when "pure" research despised its "applied" relation. But I was born a farmer, and I have taken as my guiding principle a remark of Engledow's that "if two scientific problems are of about the same interest, it seems only common sense to tackle first the one that has some practical value." So the opportunity to bring together the long range research of the Cotton Research Station in Trinidad and the applied work of the Barberton Experimental Station has been the happiest of my life. Incidentally, it is of interest to note that in doing so the Indian and West Indian traditions have been united in what I may perhaps be permitted to hope will be adopted as the African tradition in agricultural research.

Let us consider the pattern of agricultural research we hope to see established in this country. We have in our own experience a warning of the dangers of the short term view. In the years just after the war the late Dr. E. M. Crowther frequently had reason to remark on the short-sighted policy that had left East Africa without knowledge of the nutrient requirements of its soils. It had always been held that the peasant could never afford fertilizers, and it was consequently a waste of time to test them. We should all agree that we must not fall into that sort of error again. At the other extreme, the fate of the very distinguished work on cotton physiology carried out in Trinidad may be quoted. It was never planned to bear upon commercial cotton production, and when the men who carried it out left the Corporation's service there was no motive for carrying it on. It lapsed completely, and we have had to make a fresh start on cotton physiology with an entirely new approach. So we must steer between the Scylla of utilitarian planning and the Charybdis of the academic approach.

This is not too difficult if our objective is clear. I believe we should not concern ourselves unduly with current practices. The field officer

is inevitably caught up in the daily round of current farming practice. He needs informed advice on pests and diseases, on varieties and on cultural practices that are relevant to things as they are, and we in agricultural research must help him all we can. But our chief concern is not with things as they are but with things as they ought to be. It was concern with the amelioration of things as they were that so handicapped the Imperial Department in India. It was the complete inadequacy of things as they were in the West Indies that was the inducement to the Imperial Department in the West Indies to consider the things that might be achieved. We are in a like position. It must be evident to all thinking men that the pace and scope of development in Uganda is such that no mere extension of the current agricultural system will be adequate on the one hand to feed our growing towns and on the other to provide the export crop on which depend the country's ability to import the capital equipment for development. And we need more than that. We are increasingly concerned with quality, both in food crops for the improvement of nutrition and in export crops to improve our competitive position in the markets of the world.

All this is beyond the scope of a subsistence agriculture with a couple of cash crops grafted on it. What this country is going to need is modern farming, and we can't provide it until we have worked it out experimentally. I venture to suggest that the farm planners here will not disagree with me if I say that in the next year or two they will learn a great deal more than they will teach. We experimentalists must plead guilty, in the main, to having been excessively concerned with experiments, to the detriment of our understanding of the agriculture on which we are experimenting. We have learnt a great deal about the components of the agriculture of Uganda, and nothing like enough about the enterprise as a whole. So now that there is a need for farm planning we are short of information on the sort of farms we ought to plan.

This problem should dominate our research. Fundamentally we are not here to grow a bigger cotton crop, or better quality coffee, or even more food for the country and its towns, but to devise systems of agriculture that will do all these things and thereby give a better living to those who farm the land.

It is worth a moment's thought on what this will involve. At Namulunge we have devised a system for a specialist farm. We specialize in pedigree cotton seed production, and the cotton crop is therefore the focal point of our system. We have so specialized that coffee is excluded altogether, bananas are limited to small areas unsuitable for other crops, and sweet potatoes and cassava to what is required for our own staff and for cattle feed. What is included must meet two primary requirements. It must fit in with the timing of the cotton crop, and it must be suitable for rapid harvesting, and storage in the barn. Closely linked with the choice of suitable crops was the question of the practicability of double cropping. Could we take a first rains crop without prejudicing the all-important cotton crop by late planting? The answer is "Yes," but only because we have an early variety of maize (K8) as the first rains crop, and then only by an ingenious

adjustment of the system of cultivation to hasten cotton planting when the maize comes off. As so often happens, it never occurred to us to ask one of the important questions until we were well on with the development of our system. We have—as you know—spent endless time and thought on the problem of getting the cotton in early enough. We have only just begun to consider the equally tiresome problem—from the point of view of the system—of getting it out soon enough. Once you agree that it is the system that must be profitable, and not a particular crop, even the key crop cannot be allowed to stay in the ground to the detriment of its successor.

These are the sort of problems we have met in planning what we call the Nalumuli rotation, which has now settled down to a conveniently workable system of:

	<i>Year</i>	<i>First rains</i>	<i>Second rains</i>
1	:	K8 maize	cotton
2	:	groundnuts	beans
3	..	K8 maize	cotton
4, 5 and 6	..	ley	ley

The area over which this could be applied is agriculturally very important, but it must be only a comparatively small part of Uganda. As soon as you go north the mid-year dry season shortens, and your second rains crops tread on the heels of those of the first rains. First you get into areas where there may be two cropping seasons, but it is difficult or impossible to get two crops on the same land. Then you get into single crop areas. All of them require their own systems, and I would suggest that the experimental study of cropping systems over a range of climates is one of the most important needs of this country, and should dominate our agricultural botany, our entomology and our plant pathology.

Consider an example in our crop breeding work. In the breeding of BP52 cotton the proposal was made that to fit into the double cropping system worked out at Bukalasa, a short term cotton was required that could be planted late. This was an entirely reasonable proposition. However, when Manning undertook the breeding work at Kawanda he set about checking its validity under the circumstances of Kawanda in particular and the BP52 area in general. He was able to show that in much the greater part of the BP52 area the establishment of a short term cotton planted late would only be possible at the cost of a very considerable loss in yield. Now let me admit that he and I are cotton men, and our advocacy of the longer term cotton early planted was hotly pursued for the sake of cotton itself, long before we had evidence that such a cotton would fit into a profitable cropping system. However, we have now made our point, and have demonstrated that we can develop a cropping system that will make the most of the cotton crop, and also that a cotton of this duration, or even perhaps a little longer duration, does in fact fit the climatic régime in such a way as to make the best use

of the pattern of rainfall in the cotton season. We have backed up our interpretation of what we ought to do with evidence on why we ought to do it. Now this latter is, if you will, academic research. Once we knew from Manning's work when we ought to plant the crop in order to get the best yield, it may well be argued that we gain nothing more by discovering through Farbrother's work how it is that that planting date fits our rainfall régime. We can't alter the rainfall, and we merely worry more than we used to when the October rains are short.

I am not trying to argue that we should pursue knowledge solely for its own sake. We have found that this kind of knowledge is of very real practical value. Some of you know of the project now nearing completion to set up rainfall diagrams covering very closely the diverse rainfall régimes of Uganda. With these and our knowledge of the seasonal march of water requirements of our cotton crop, we are in a much better position to give detailed advice on optimum sowing date. More than this, we are now getting to the stage where we can write a specification for a cotton variety. This sowing date debate is still not at an end, but we can now see an outline of a physiological account that will reconcile Jameson's demonstration of the difference between N17 and S47 in response to sowing date, and Walton's showing that existing data do not give an account of dates early enough to set the optimum date for cottons of the S47 type. It now appears that a cotton should fit the season in three respects. The planting date should be such as to make the best use of the total rainfall expectation of the growing season. The peak of leaf area should be reached at the time the peak of rainfall is expected. And the crop should begin to open as the dry season sets in. Consider the application of these principles to Gulu. There is effectively a single wet season from mid April to mid November, with the peak of rainfall at the end of August. At Namulunge with BP52 cotton, well grown, one may set the peak of leaf area at about the eighteenth week, and complete senescence at twenty-sixth week. At Gulu, counting mid April as week 0, the peak of rainfall comes at week 19, and the end of the rains at week 30. Thus, cottons of the duration of current Uganda varieties if planted at the beginning of the rains at Gulu would reach the peak of leaf area at about the right time, but would crop before the end of the rains. As Manning has pointed out, the optimum planting date at Gulu is determined in fact by the duration of the crop and the need to get it ripening in dry weather, and not by the pattern of the rainfall. It now appears that with current varieties the peak of leaf area must not be reached until after the peak of rainfall, or the crop will be reaped in wet weather, and it follows that a better fit to the climate would be achieved with a cotton variety having a longer vegetative term and a later crop.

This brings us back to the farming system again. What would be the effect of such a cotton variety on the system as a whole? And in particular, what would be the effect on the status of such pests as *Lygus* and bollworm which attack more than one crop in the system? Let us return to Namulunge for a moment. We have both *Lygus* and American bollworm, and we started off with the theory that by controlling *Lygus*

we could greatly increase the size of the cotton crop. The main outcome of the *Lygus* work has been to show the extent to which cotton that is timely planted can compensate for the attacks of the pest. Bollworms are more serious, as they tend to attack so late in the season that compensation is impossible. The question then arises as to whether we are by our farming system creating a pest hazard for ourselves. It appears that under our circumstances we are not, since the size and timing of the bollworm attack on cotton does not appear to be affected by the extent of the maize or sunflower crops either in the previous rains or in the same season. We are fortunate, and this state of affairs does not hold in other places. We are able to plan our maize crop, and determine the variety we shall grow, regardless of the time of cropping and of release of bollworm moths that might move on to the cotton. In many areas the timing of grain and cotton crops may make the difference between escape from pests and a catastrophic attack. The problems involved are well illustrated by Eastern Province experience, where the timing of the grain crop is such as to release a large population of *Lygus* from the harvested grain into the flowering cotton, often with disastrous consequences. Pest control then becomes an exercise in the adjustment of the farming system, in which both plant breeders and entomologists are involved. Both the cotton breeding and the food crop breeding must be subservient to the system, and in my opinion where there is a problem such as *Lygus* in eastern and northern Uganda it is of the utmost importance that both the breeding projects and the associated entomological work should be done on the same station. If there is a head-on collision between the requirements of a secure food supply and those of an adequate cash crop, it should be under constant study on the experiment station. Pest control by insecticides and pest avoidance by crop timing and breeding crop varieties of suitable duration must be studied together as part of a farming project and not as a series of unrelated specialist experiments. It is not enough merely to have food crop breeding and cash crop breeding side by side, with an entomologist to watch the pests skip from one to the other. Most of the work on an experiment station ought to be farming, and the farm manager is the man who should be telling the specialist whether or not he is talking sense.

Every experiment station ought to be able to demonstrate the economical operation of a farming system. We must exclude the profit motive. No experiment station ever produced both information and profits, and it is information that it is our business to provide. But it is all too easy on an experiment station to say that, for instance, the cotton must be early planted and therefore the first rains crop must if necessary be sacrificed. It was not until we stopped that sort of thing that the real limits of choice of first rains crops became evident. What we have to do, as Parnell used to say, is to lose the experiments in the farming system.

To conclude, let us admit no distinction between long term and short term research. They are parts of the same thing, and their artificial separation serves no purpose save to make a short-sighted policy look meritorious. We have no time to take the short view. The long term

problems are upon us. We in Buganda have not yet solved the problem of a storable food supply for the towns—a long term problem if ever there was one. But count the bakeries that have sprung up in Kampala. The problem is solving itself by the import of wheaten flour, in defiance of the most explicit statement of policy that "not only the Protectorate as a whole but each district should be self-sufficient in its staple foods so far as is practicable" and, mark you, "that administrative action should be taken where necessary to ensure that this is achieved" (Report of the Agricultural Productivity Committee). What action would we recommend the administrators to take to ensure that an adequate supply of good quality storable food was available from local sources to compete with wheaten flour in Kampala?

Our objectives must be long term. The short term finding and the immediate application are incidental to our work, and not the main issue. We must be concerned with better farming systems that may not be applicable in this country until we have better planned land use, better farms, and better farmers than we have today. Let us not be put off by objections that land tenure systems do not permit of this kind of organization, and the men in the countryside can neither understand nor value the things we demonstrate. We have got to break the vicious circle somewhere, and our job is to break it by offering highly productive systems to people who are beginning to want the fruits of productive labour.

We have experience of the piecemeal approach, with our "commodity research" and our limited projects. The time has now come to take the wider view and merge the commodity in the farming system. The increasing interest in farm planning is a sign of the times, and we who work on experiment stations ought to have foreseen ten years ago that it might come, and should have planned our long term research accordingly. We should have had a lot more to offer the farm planner than we now have. The farm planners will—quite rightly—ask a great deal of us, and we shall probably hear again the argument that immediate needs are so urgent that long term research must wait. But the urgency of immediate needs arises from the fact that long term research was allowed to wait ten years ago. Let us break away this time, and look ahead so that we can lead the agricultural revolution, not follow in its wake.

## SPRAYING TRIALS ON PEASANT COTTON IN UGANDA IN 1957

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TRIALS have been conducted in Uganda for the past ten years on the insecticidal control of cotton pests, mainly in the northern areas, where the variety "S47" is grown, culminating in an extensive series of trials on peasant cotton in 1957. The detailed results of this work are being prepared for publication elsewhere, but the 1957 experimental results are considered of sufficient interest to be described separately, more so since they form the basis of an intensive propaganda campaign for spraying the 1958 crop.

The main conclusions on which the 1957 trials were based were:

- (a) Spraying is more effective than dusting.
- (b) 1 lb. DDT per acre, applied four times at intervals of ten days, achieved a considerable reduction in the damage usually ascribed to *Lygus*.
- (c) That a spray applied at some time during the 6-14 week period of growth invariably formed part of the most successful spray schedules.
- (d) A simple double-acting syringe pump, capable of spraying at 8-12 gallons per acre, would be an adequate instrument for cotton farmers, and was in fact available.

The vast majority of previous trials had been carried out at Serere Experiment Station of the Department of Agriculture, in Eastern Province. Some dusting of peasant cotton had been done as far back as the 1950-51 season, but thereafter nothing was done until 1953-54, when a small acreage was sprayed, since when the acreage sprayed has slowly increased, almost entirely at the growers' request. The consensus of opinion was that there was insufficient evidence to justify active Departmental propaganda in favour of spraying, and to obtain this the 1957 extension trials were planned and carried out.

One hundred plots of approximately 1 acre were chosen in five areas, from South Teso (Eastern Province) to central Acholi (Northern Province), covering the main spread of S47 cotton, and also in Bunyoro, which grows the variety BP52. A range of planting dates, from early May to mid-July, was included, four plots in each area for each planting date; giving a total of twenty plots, spread over an area of several square miles in each site. As far as possible it was insisted that all plots were kept at a high standard of husbandry, and in the main this objective was achieved. As indicated, the standard treatment was four applications of 1 lb. DDT per acre (from a 25 per cent. miscible liquid) at 10-day intervals, applied by the growers themselves by means of a simple syringe pump under Departmental supervision. Within each plot half was sprayed, half unsprayed, thus giving an approximate half-acre for each treatment,

and an approximate overall total of 50 acres sprayed and 50 unsprayed, spread over a 10-week planting period.

The results have been very satisfactory. It is possible to analyse them as for a randomized block layout. For this purpose yields have been standardized to yield per acre, and five arbitrary planting periods adopted, Early May (EM), Late May (LM), Early June (EJ), Late June (LJ), and Early July (EJy), early and late corresponding to 1st-14th and 15th-30th (31st) of the respective months. The latter arrangement has an obvious disadvantage in that two plots separated by one day in planting time will be allocated to two different planting periods. Bearing this point in mind, the analysis of variance can be arranged as follows:

Planting date .. .. ..	with 4 degrees of freedom
Error "a" .. .. ..	15 "
Spray v. control .. .. ..	1 "
Spray $\times$ planting date interaction .. .. ..	4 "
Error "b" .. .. ..	15 "
Total .. .. ..	39 "

By plotting yield against time of planting, here estimated as days from April 30th, regression curves can be constructed for both sprayed and unsprayed plots for each area. The results of the analysis of variance and of regression of yield on time are given in Table 1 and Fig. 1.

TABLE 1.—ANALYSIS OF VARIANCE: SIGNIFICANCE OF SPRAYS WITHIN PLANTING DATES

	EM.	LM.	EJ.	LJ.	EJy.
Kidongole .. .. ..	*	*	**	***	
Omoro .. .. ..	***	**			
Anyeke .. .. ..	***		*		
Lakwatomer .. .. ..	***	***	**	*	**
Hoima-Masindi .. .. ..	*				*

Planting dates: Omoro \*, Anyeke \*.

Interaction, spray  $\times$  planting date: Kidongole \*, Omoro \*\*.

Table 1 indicates that overall a high level of statistical significance was achieved. However, the regression lines provide a more realistic assessment in terms of economic returns from spraying, and also provide interesting agronomic data. At the prices paid to growers in the 1957-58 season for seed cotton, 55-57 cts. (E. Afr.) per lb., an increase of approximately 130 lb. seed cotton per acre was required to cover the cost of spraying—66s. per acre, this amount including a depreciation element on the spray pump. The following conclusions can be drawn:

*Kidongole.* The regression shows that spraying is uneconomic after late May. Statistically a very highly significant ( $P < 0.001$ ) difference occurs between sprayed and unsprayed as late as the end of June. This discrepancy is probably explained by the fact that the control regression line is almost certainly incorrect. The correlation coefficient for this line is  $r = -0.35$ , which is not significant. Also, of course, statistical significance is not necessarily the same as economic significance. It is, however, doubtful whether spraying in the Kidongole area would be economically worth while much later than early June because of the generally low yields in that area, a statement supported by the

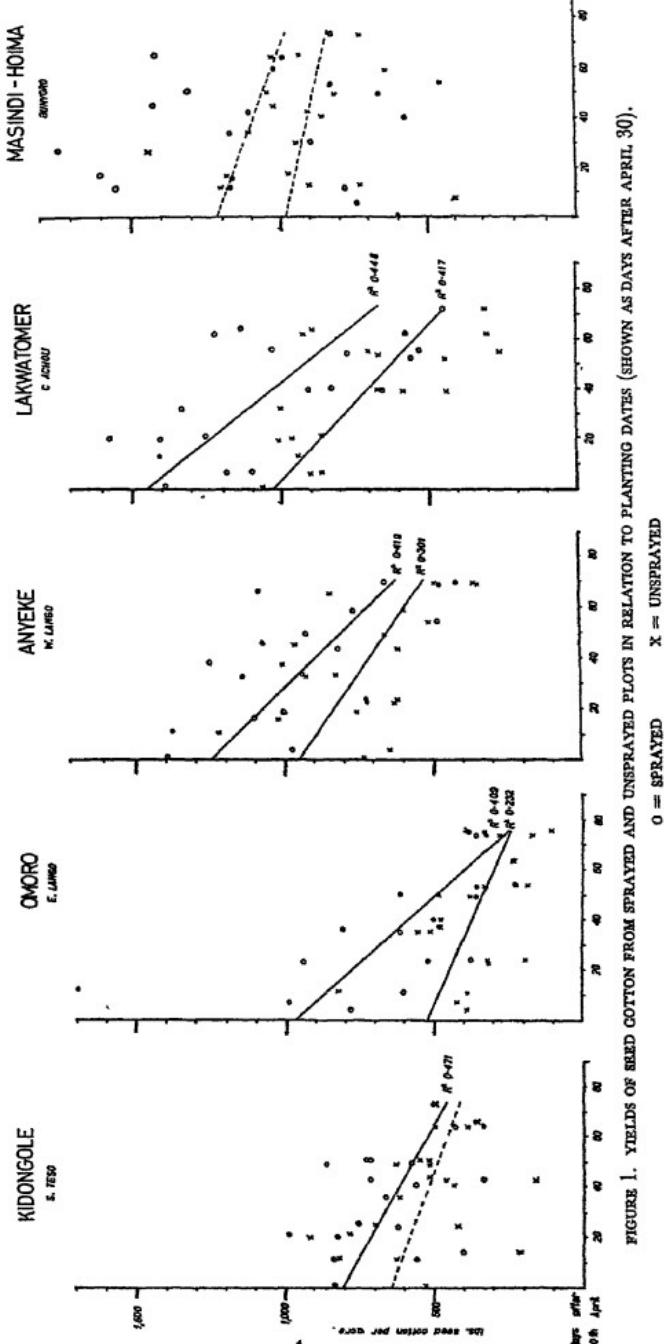


FIGURE 1. YIELDS OF SEED COTTON FROM SPRAYED AND UNSPRAYED PLOTS IN RELATION TO PLANTING DATES (SHOWN AS DAYS AFTER APRIL 30).

significant ( $P=0.05$ ) interaction between planting date and spraying. Thus, one may expect the best returns from spraying to be obtained from the earliest planted cotton.

*Omoro.* Spraying became uneconomic after late June. It may be noted that the interaction between planting date and spraying was highly significant ( $P=0.01$ ), a result amply confirmed by the marked difference in slope of the two regression lines for Omoro.

*Anyeke.* Spraying after mid-June was uneconomic. While there was no significant interaction between spraying and planting date, the difference in slope of the two regression lines again indicates that by far the best returns are obtained from spraying the earliest planted cotton.

*Lakwatomer.* The difference in slope of the two lines is here the least for any area, with the result that spraying was economic throughout. But since the control regression line shows that a sharp fall off of yield occurs with later planting dates, one should plant early, irrespective of whether the cotton is sprayed.

*Hoima-Masindi.* Neither the sprayed nor unsprayed regression coefficients are significant, and they have thus merely been indicated. Since they conform to the pattern shown by all the other areas, one may tentatively conclude that spraying is not to be recommended after the end of June; although the analysis of variance shows a significant difference between treatments for early July. Bunyoro is however a BP52 area, and is climatically different from the other areas discussed, in that the late rains are heavier and more evenly distributed than in the S47 zone and therefore the onset of water stress is considerably delayed. It is generally conceded (see e.g. McKinlay and Geering, 1957; Coaker, 1957) that results of spraying BP52 cotton, in Buganda at least, are inconclusive and rarely show the clear-cut differences obtained in the S47 areas. The 1957 results show that spraying BP52 cotton in Bunyoro is probably a better proposition than further south in Buganda, and the Department of Agriculture is in fact recommending spraying the 1958 crop.

It is to be noted that in all areas the sprayed and unsprayed regression lines converge to a point after July. It is most unlikely that no pests exist after this date, the probability being that, owing to water stress, the plant is unable to hold any of the fruiting points saved by insect control.

Agronomically the data obtained support the conclusions of Walton (1958) on the losses due to delay in planting. In Table 2 the theoretical yield lost, expressed as a percentage of the yield at May 1st, is given for 30 days' delay (= May 30th) and 60 days' delay (= June 29th) for the

TABLE 2.—PLANTING DATE AND YIELD—UNSsprAYED  
COTTON, S47 AREAS  
*Percentage yield lost due to delay in planting*

District		30 days	60 days
Kidongole ..	.. ..	12	26
Omoro ..	.. ..	17	37
Anyeke ..	.. ..	15	34
Lakwatomer ..	.. ..	21	46

S47 areas. In Lakwatormer one month's delay cost nearly a quarter of the yield of early May, and two months' delay nearly half. In the other districts losses range from about an eighth to a third. These figures, taken with those of Walton (1958), leave no room for doubt that with S47 cotton serious losses are caused by late plantings.

### Summary

Significant increases of yield have been shown to result from spraying S47 cotton in Uganda, though economic returns accrue only from early (May to mid-June) sown cotton. It is also probable that economic returns result from spraying BP52 cotton in Bunyoro, although the results obtained in this area are not so conclusive as those obtained from the S47 zone.

Data obtained from unsprayed plots have confirmed that a linear relationship exists between planting date and yield, and that later plantings progressively reduce yield.

### Acknowledgments

Most of the work that led up to the trials was that of Mr. A. P. G. Michelmore and Mr. T. R. Jones of the Section of Entomology, Department of Agriculture. The field conduct of the trials was the responsibility of Mr. B. G. Thompson of Plant Protection Ltd., and Mr. Ll. Green of the Department of Agriculture. Messrs. Gowa, Kiriggwajo, Kiboigo and Mabizzi each had charge of a district. To all of these gentlemen thanks are due for the admirable way in which the trials were conducted. The paper is published with the permission of the Director of Agriculture.

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*Received July 1958.*

## FEEDING OF THE COTTON APHID (*APHIS GOSSYPII* GLOVER)

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### Introduction

*Aphis gossypii* Glov. is a widely distributed species important as a pest of cotton and melons. The external signs of damage by this insect on cotton have been described by various authors, e.g. Wilcocks and Bahgat (1937). No investigations have however been made on the internal damage resulting from feeding, the way the stylets penetrate the plant, or the plant tissue utilized in feeding. It is with these latter aspects that the present paper is concerned. The work was carried out at the Faculty of Agriculture, University of Khartoum, during 1955-57.

### Materials and Methods

Nymphs and apterous parthenogenetic females were studied on the following cottons:

1. American (*Gossypium hirsutum* L.)  
“Philippines Ferguson” (*G. hirsutum* race *latifolium*).
2. Egyptian (*G. barbadense* L.)  
“BAR 14/25”: blackarm-resistant “Sakel.”  
“BLJR 14/36”: blackarm-leafcurl-jassid-resistant “Sakel.”

(“Ferguson” and “14/36” are hairy-leaved cottons; “14/25” is glabrous.)

Examinations were made of young and mature, infested and uninfested leaves collected in the field and from insectary plants. Living aphids were observed on leaves attached to the plant but held in plastic clamps, while killed aphids were studied *in situ* in the same way, or after fixing and sectioning. Aphids were killed by plunging the leaf into 50 per cent. formalin at 60° C. for 3-4 seconds. This gave results superior to those obtained with chloroform, hot fixatives or wax drops. In fixing,  $\frac{1}{2}$  cm. sq. pieces of leaf were immersed in Carnoy’s fluid for 3 hours under reduced pressure. Clearing was by chloroform or xylol, embedding in paraffin wax (m.p. 68° C.). 4,000 sections, 20  $\mu$  thick, were cut and examined. Flemming’s triple stain (safranin, gentian violet, orange G) was generally used for staining.

### The Mouth-parts

The following is a brief account of those features of the mouth-parts relevant to the present work:

At the commencement of insertion of the stylet bundle into the leaf, the rostrum is straight and head raised well above the leaf surface. As

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the stylets sink into the tissue the rostrum shortens, eventually bending, so that segment 1 of the labium is reflexed beneath the head, segment 2 bends forwards below 1, while 3 and 4 remain at right angles to the head. The attainment of this position takes about 20 minutes. The length of the stylet bundle, including that part within the head, varies from 280  $\mu$  (nymph 1) to 420  $\mu$  (adult). In the former, 86-140  $\mu$  of the bundle may be extruded beyond the tip of the rostrum, and in the latter, 90-200  $\mu$ , when the insect is feeding. The mean extrusion distance of the bundle ranges from 106  $\mu$  (nymph 1) to 118  $\mu$  (adult)—this is equivalent to distances of 98  $\mu$  and 110  $\mu$  respectively, in leaf tissue, since the effective length of the stylet bundle is approximately 7 per cent. less than the actual length as a result of bending. The diameter of the stylet bundle varies from 2.2  $\mu$  to 4.5  $\mu$  according to instar. The mandibular stylets are not barbed or serrated and can be easily separated. The maxillary stylets are almost identical in length to the mandibulars, adhere closely together, and can be protruded beyond the latter. Stylets inserted in the leaf are often twisted, and of twenty examples studied, eight had a clockwise and six an anticlockwise rotation. The amount of rotation in the above samples varied from 5° in a 70  $\mu$  length, to 180° in a 10  $\mu$  length, of stylet bundle.

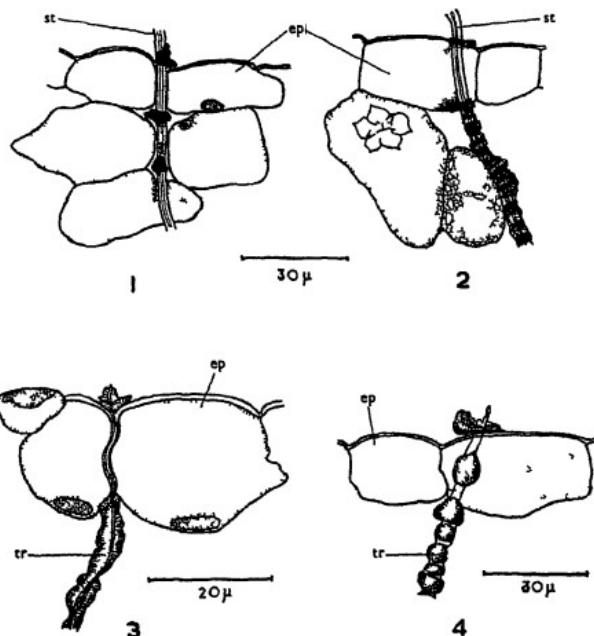
### Location of Feeding Aphids

Cotton aphids occur on the undersides of young and mature leaves, though adults may sometimes be found on the upper surface. On young plants all stages may in addition infest the petioles and stem. An examination of 50 randomly chosen apterous adults killed *in situ* and dissected from the leaves of glabrous "Sakel" plants showed that 78 per cent. had the stylet bundles embedded in the veins, 22 per cent. in the lamina. In sections of "Ferguson" cotton leaves, examination of 60 stylets and tracks from various instars showed that 77 per cent. were inserted in the veins, 23 per cent. in the lamina. Disturbance of feeding aphids causes them to wander for short periods (up to 5 minutes) before settling and re-inserting the stylets. This re-insertion may take place on a vein or on the lamina. The former is more common and although short probing periods (under 10 minutes) may be recorded there, the aphid eventually settles to feed for long periods (30 minutes and over). When settling occurs on the lamina, short probing periods (15 seconds—4 minutes) are the rule: periods over 10 minutes are rare.

### Penetration of the Epidermis

The path of the stylet bundle through the epidermis, whether in vein or lamina, is predominantly intercellular. Examination of stylets and tracks in "Ferguson" and "14/36" cotton showed that 84 per cent. penetrated intercellularly, 12 per cent. intracellularly, and 4 per cent. via a stoma.

Detailed figures for each variety are given in Table 1. Where penetration by the stylets is intercellular, the stylet (salivary) sheath is absent or extremely thin in the course between the tightly packed



FIGS 1-4.—*Aphis gossypii* GLOV. STYLES AND TRACKS IN COTTON LEAF TISSUE.  
 (1) Intercellular and (2) intracellular penetration of epidermis (ep) by stylet  
 bundle (st) (3) Intercellular and (4) intracellular penetration tracks (tr)

epidermal cells (Fig. 1). Similarly with tracks, that part within the epidermis is absent or greatly reduced (Fig. 3). Beneath the epidermis, sheaths and tracks are well developed (Figs. 2, 3) unless the intercellular spaces between the mesophyll cells are small, when the converse may

TABLE 1.—PATH OF STYLETS AND TRACKS OF *Aphis gossypii* THROUGH LEAF EPIDERMIS OF COTTON

<i>Cotton variety</i>	<i>Ferguson</i>			<i>BLJR 14/36</i>	<i>Both</i>
Intercellular .. .. .. .. ..	<i>S</i>	<i>T</i>	%	<i>S</i>	<i>T</i>
Intercellular .. .. .. .. ..	18	36	82	13	2
Stomatal .. .. .. .. ..	4	5	14	1	0
Number of specimens examined .. ..	66			16	82

Stylet (*S*), track (*T*), percentage of both (%).

occur (Figs. 1, 6). Where stylet penetration is intracellular, traces of the sheath (Fig. 2) or track (Fig. 4) may be found within the pierced epidermal cell. A thin walled non-staining or faintly staining tube may be present as an inner lining to the tracks. Where penetration is intercellular, the tube is compressed by the epidermal cells (Fig. 3), but where it is intracellular, a cylindrical shape is retained (Fig. 4). The nature and origin of this structure is unknown. However, since the cotton aphid may moult while the stylets are inserted in the leaf, it is possible that this tube represents part of the moulted stylet bundle.

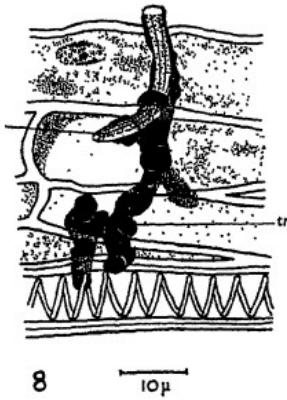
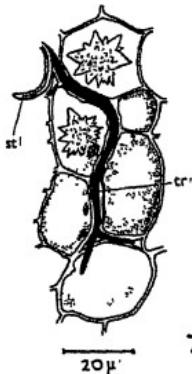
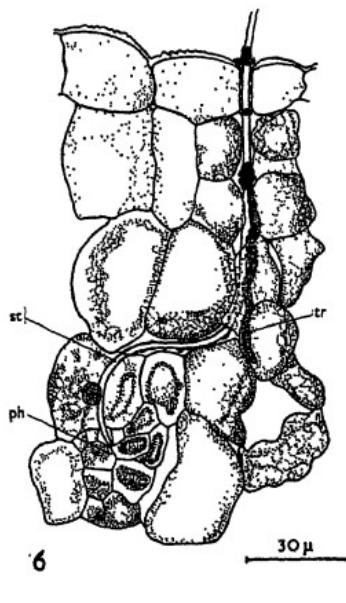
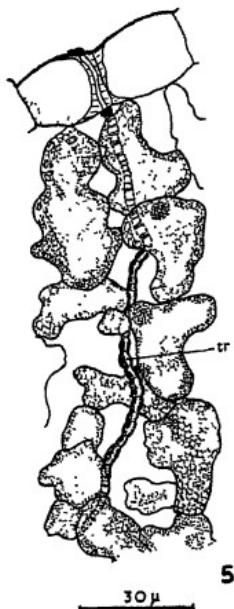
On the surface of the epidermis an "epidermal plug" may be found associated with a stylet bundle or a track. In the former case it surrounds the stylets (Figs. 1, 2, 6), in the latter it is attached either to the end of the track or to the inner tube mentioned above (Figs. 3, 4). This plug, which in appearance and staining reaction resembles the rest of the sheath or track, has typically a broad circular base 4·9  $\mu$  diameter with a perpendicular tube 3·9  $\mu$  long (mean dimensions in a sample of 18 were: 6·8  $\mu$  and 5·7  $\mu$  respectively).

Damage to the epidermal cells is not evident except in cases of intracellular penetration where plasmolysis may occur.

### **Penetration of the Mesophyll**

In traversing the leaf mesophyll, stylets and tracks pass through some three to five layers of loosely packed cells. Considering the "Ferguson" and "14/36" varieties together: in 56 per cent. of cases examined, the stylet or track followed an intercellular course, in 16 per cent. the course was intracellular, while in 28 per cent. the course was partly inter- and partly intra-cellular (Table 2).

The stylet or track may take a more or less straight course through the mesophyll (Fig. 5) or it may bend or alter course markedly (Fig. 6) before reaching the vascular tissue. Collenchyma, which was more plentiful in the Egyptian cottons examined, does not appear to hinder



Figs. 5-8.—*Aphis gossypii* GLOV.: STYLETS AND TRACKS IN COTTON LEAF TISSUE.  
 (5) Intercellular track (tr) ending in mesophyll. (6) Intercellular penetration by stylets (st) to the phloem (ph). (7) Track (tr) showing penetration between middle lamellae. (8) Stylets (st) and track (tr) terminating in the phloem.

stylet penetration, as intercellular paths up to 60  $\mu$  long have been recorded in this tissue.

The sheath surrounding the stylet bundle is well developed in *A. gossypii*. It has a beaded (Fig. 4) or banded (Fig. 2) appearance resulting from deposition of saliva drops at the rate of three to five per 10  $\mu$ . The mean width of the sheath is 5.1  $\mu$ , but the same structure

TABLE 2.—PATH OF STYLETS AND TRACKS OF *Aphis gossypii* THROUGH LEAF MESOPHYLL OF COTTON

Cotton variety	Ferguson			BLJR 14/36			Both
	S	T	%	S	T	%	
Intercellular .. .. .. ..	11	16	60	6	2	47	56
Inter- and intra-cellular .. .. .. ..	6	4	22	6	1	41	28
Intracellular .. .. .. ..	5	3	18	2	0	12	16
Number of specimens examined .. ..	45			17			62

Stylet (S), track (T), percentage of both (%).

(track) after withdrawal of stylets has a mean width of 3.0  $\mu$  (thirty specimens). The sheath is most prominent where the stylet bundle is traversing an intercellular space and is feebly developed—or in extreme cases absent—when the stylets are closely surrounded by mesophyll cells (Fig. 6) or when penetration is intracellular (Fig. 1). An exception to this occurs in the penetration of vascular and adjacent tissue. There, intercellular penetration between the walls of closely applied cells is frequently accompanied by sheath formation, and the resultant track may acquire a smooth outer surface—presumably from pressure by the surrounding cells (Fig. 7).

Tracks may be beaded or banded like sheaths, but as they age their outlines become less distinct, staining reaction to safranin weakens, and the surface becomes vacuolated. Distortion of tracks may be caused by cell pressure, and like sheaths, tracks may be discontinuous. In the latter event, the parts are frequently held together by the presence of an inner tube surrounding the lumen.

Intracellular penetration causes laceration of the cell wall and in some instances deposition of saliva in the cell. Apart from this, no clear evidence has been obtained of damage to the mesophyll. The cells bordering an intercellular penetration remain normal in appearance, chloroplasts do not diminish in size or number, nuclei show no tendency to migrate towards the stylets and the cytoplasm does not plasmolyse.

#### Destination of Stylets and Tracks

The principal destination of the stylets of *A. gossypii* is the phloem tissue of the cotton leaf. Of all stylets and tracks examined in sections of "Ferguson" and "14/36" varieties, 77 per cent. ended in vascular, and 23 per cent. in non-vascular, tissue. These were distributed as follows: phloem, 67 per cent.; xylem, 10 per cent.; mesophyll, 21 per cent.; and palisade tissue, 2 per cent. (see Table 3).

TABLE 3.—DESTINATION OF STYLETS AND TRACKS OF *Aphis gossypii* IN COTTON LEAF TISSUE

Cotton variety	Ferguson			BLJR 14/36			Both
	S	T	%	S	T	%	
Vascular tissue ..	19	19	72	13	3	94	77
Non-vascular tissue ..	3	12	28	1	0	6	23
Phloem ..	18	16	64	12	1	76	67
Xylem ..	1	3	8	1	2	18	10
Mesophyll ..	2	12	26	1	0	6	21
Palisade ..	1	0	2	0	0	0	2
Number of specimens examined ..	..	..	53	..	..	17	70

Stylet (S) track (T), percentage of both (%).

The mean distances from upper and lower epidermal surfaces of a leaf to the periphery of the phloem are 178  $\mu$  and 81  $\mu$  respectively in "Ferguson" and 179  $\mu$  and 75  $\mu$  respectively in "14/36." Early instar nymphs are thus unable to reach the phloem from the upper surface and adults can only do so when these distances are considerably less than the mean or stylet extrusion is at a maximum. The average thickness of phloem tissue is 40  $\mu$  in both cotton varieties. Stylets and tracks generally penetrate to a depth of 15-35  $\mu$  in this tissue, the penetration being less with "Ferguson" than "14/36," and greater with adults than nymphs. Exceptionally, greater depths may be encountered, e.g. a stylet penetration of 66  $\mu$  has been recorded in the phloem of a large vein. Examination of horizontal sections shows that penetration by the stylet bundle is mainly along the middle lamellæ of the phloem and xylem elements. Branched tracks (Fig. 8) indicate repeated probing by the stylets. The stylet apex, when inserted in a cell, is generally not covered by the sheath (Fig. 8). Termination of stylets or tracks in palisade tissue is rare: termination in mesophyll is more common, particularly for tracks (see Table 3).

Damage to the vascular tissue may arise from physical blockage of the sieve tubes and—to a lesser extent—vessels. The mode of penetration of stylets, i.e. along middle lamellæ, minimizes the risk of this, but accumulations of salivary secretion up to 10  $\mu$  wide and sufficient to block small cells have been seen. Stylets and tracks may also be associated with plasmolysed phloem cells, though of fifty-four samples examined, only twelve showed plasmolysis and in none of these was it extensive. No proliferation of cells has been seen in phloem tissue riddled by old tracks.

#### Rate of Stylet Penetration into the Leaf

The rate of penetration was determined by measuring the length of stylet bundle extruded, in known time, by adult aphids. For each test, a "14/25" (glabrous) cotton leaf attached to the plant was clamped under a binocular microscope and an apterous adult allowed to settle for feeding. Timing commenced with insertion of the stylet bundle.

At the expiry of the allotted period, the insect was killed with a drop of chloroform, removed from the leaf, and length of protruded stylet bundle measured. Ten aphids were examined after each of nine periods, the latter being: 1, 2, 4, 8, 12, 16, 20, 24 and 32 minutes. Further observations on twenty stylet bundles in leaf sections showed that the decrease in effective length of the bundle as a result of bending was approximately 7 per cent. Knowing the effective length of stylet bundle extruded in a given time, and the thickness of the leaf tissues, it is possible to estimate the progress of the stylet apex through the leaf. Briefly, this is as follows.

Initial penetration is extremely rapid: the tip of the stylet bundle traverses the epidermis in 42 seconds and is half-way through the mesophyll in 2 minutes. The rate of penetration then decreases slowly so that the whole of the mesophyll is not traversed until 9 minutes have elapsed from the commencement of insertion. At this point the stylets encounter the vascular tissue and the rate of penetration decreases very rapidly so that a further 10 minutes (making a total of 19) is required to pass through the first  $6\ \mu$  of phloem cells. Once this initial penetration of the phloem tissue has been accomplished, the insertion rate increases again and about  $26\ \mu$  of phloem is traversed in 8 minutes. After this, penetration rate drops for the second time and the stylet apex comes to rest at an average depth of  $110\ \mu$  from the surface in about 30 minutes. It is possible that later bursts of penetration may carry the stylet apex into the xylem, but this has not been studied.

### Discussion

*Aphis gossypii* is similar to most aphids studied by other investigators in that penetration of epidermis and mesophyll is mainly intercellular, the saliva gels to form a sheath, and feeding occurs in the phloem. Some intracellular penetration occurs in the epidermis and mesophyll but does not necessarily indicate feeding in those regions. In a few aphids, e.g. *Macrosiphum gei* Koch. on tobacco (Roberts, 1940), penetration is predominantly intracellular, while in others it is predominantly intercellular, e.g. *Myzus circumflexus* Buckt. on potato (Smith, 1926). Either method of penetration may or may not be accompanied by damage to the mesophyll. Where such damage occurs, it may take the form of laceration, plasmolysis or chloroplast destruction (Davidson, 1923; Carter, 1939). In the latter two cases it is caused mainly by the saliva or a salivary toxin and is generally assumed to be associated with feeding activity. The extent of damage and feeding varies greatly with the host plant and the condition of the insect. Thus *Myzus persicae* Sulz. may cause extensive damage to potato leaf mesophyll (Smith, 1926) but only slight damage to tobacco and sugar beet (Roberts, 1940); *Macrosiphum gei* may plasmolyse leaf mesophyll in potato (Dykstra and Whitaker, 1938) but not in tobacco (Roberts, 1940); the feeding of *Myzus persicae* in non-vascular tissue is associated with prior starvation (Watson and Nixon, 1953). It is clear that *A. gossypii* is not responsible for damage of the types mentioned above, on cotton: there is no apparent diffusion of saliva, plasmolysis and chlorosis are absent and branched tracks—indicative of repeated probing—do not occur in the mesophyll.

The mode of penetration of the stylets of *Aphis gossypii* in cotton appears to be very similar to that observed by Celino (1940) in the same species on Manila hemp (*Musa textilis* Née). There, feeding occurs in the phloem and the stylets pass mainly intercellularly, occasionally intracellularly, through the mesophyll.

The nature of the sheath and track has been the subject of numerous investigations: the evidence suggests that these structures are mainly, if not wholly, of insect origin. Smith (1933) detected chitin in the tracks of *Stictocephala festina* Say. (Membracidae) and *Empoasca fabe* Harr. (Jassidae) and concluded that this substance is secreted by the salivary glands of these insects. A more likely origin of this material is the moulted stylets left in the tracks after ecdysis: *in situ* moulting of the stylets is common in *A. gossypii* and can also be found in leafhoppers, e.g. *Empoasca libyca* de Berg. Several writers have noted the "epidermal plug" associated with the tracks of aphids, e.g. Davidson (1923), Smith (1926). The former author considered that they were produced by a "welling up of sap" into the track immediately after withdrawal of the stylets. In *A. gossypii*, however, the plug is present while the stylets are still *in situ* and appears to be produced by the extrusion of saliva immediately before or just after penetration of the epidermis.

The twisting of embedded stylets has seldom been recorded in aphids and is of unknown significance. Butt (1943) related twisting to stylar and labral structure in certain Homoptera and suggested that it is associated with a drilling motion of the stylets when the latter are penetrating plant tissue. Twisting could also be produced by rotation of the aphid about the fixed point of stylet insertion.

Since *A. gossypii* produces abundant honeydew and the stylets and tracks—the latter often branched—end mainly in the phloem, it may be assumed that this aphid is a typical sap feeding species. Penetration through the phloem is along the middle lamellæ. Davidson (1923) ascribes this mode of progress to the solvent action of saliva assisted by mechanical pressure. In view of the readiness with which the saliva gels, however, the latter of these processes would seem to be more important in *A. gossypii*. The rate of penetration of the bundle through cotton leaf tissue is similar to that in *Myzus persicae* and other species in different host plants (Bradley, 1953; Roberts, 1940). As previously noted, there is little evidence of damage in the phloem tissue of cotton leaves attacked by *A. gossypii*. Some blockage of this tissue probably occurs, but is insufficient to cause carbohydrate accumulation on the scale produced by leafhoppers (Johnson, 1934). External signs of damage are—in comparison with mirids or jassids—very slow in appearing. Furthermore, such damage (crinkling and curling of leaves, possibly formation of pseudo-vascular tissue) is only produced by the prolonged exposure of leaves to the feeding of large colonies of aphids: the detectable damage inflicted by single aphids is very small.

### Summary

The stylets of *Aphis gossypii* Glov. pass mainly intercellularly through the leaf epidermis and mesophyll of Egyptian and American cottons.

Some intracellular penetration may occur in both tissues: entry through the epidermis is rarely via a stoma. The stylets follow an indirect path to the vascular tissue (mainly phloem) in which feeding occurs. Penetration through the phloem takes place along the middle lamella and is accompanied by sheath formation. Stylet sheath and track are well developed except where epidermal and mesophyll cells are closely packed. The rate of insertion of the stylets is rapid in epidermis and mesophyll but drops appreciably in the phloem: they come to rest in the latter some 30 minutes after the commencement of insertion. There is no evidence for diffusion of saliva through the leaf tissue. Plasmolysis is rare—except in the phloem where it is only slight—and chlorosis is absent. Slight blockage of phloem cells may be caused by branched tracks.

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Received April 1958.

# THE USE OF THE INFILTRATION METHOD IN THE STUDY OF THE BEHAVIOUR OF THE STOMATA OF UPLAND COTTON

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## Abstract

SOME factors involved in the use of the infiltration technique for studying stomatal behaviour are discussed and preliminary results using cotton are described. The criticism that pure iso-butanol does not penetrate stomata of small aperture does not seem to apply for the cotton plants investigated.

Comparison of arbitrary "scores" for infiltration with leaf resistance as measured with a Wheatstone bridge porometer shows a high correlation for fully turgid plants.

## Introduction

The water relations and assimilation rates of higher plants are thought to be controlled in part by the stomatal apparatus. Since a considerable amount of research at Namulonge had been devoted to crop water relations it was thought necessary to investigate the response of the stomata of cotton at Namulonge to a number of different environmental conditions.

Several field techniques for investigating stomatal behaviour have been devised; of these, the simplest and most useful is the infiltration technique first used by Molisch (1912) and Stahl (Stein, 1912). Stålfelt (1916) has reviewed the technique and subsequently many workers have used the method. This paper records details of the technique used at this station, together with some preliminary results. It is hoped to publish detailed results elsewhere, at a later stage.

## Principle

Molisch's technique consisted of applying in succession small drops of ethanol, benzene or xylol on to the surface of the leaves under investigation. If the stomata were wide open all three solutions penetrated the stomatal pores and injected the adjacent intercellular spaces. If the stomata were partly shut ethanol would not penetrate, and if closure were still more marked only xylol would inject the substomatal cavity. Infiltration was thus related qualitatively to stomatal aperture.

The penetration of a liquid drop into the intercellular spaces of a leaf will depend upon two main factors: (a) dimensions of the stomatal aperture and of the intercellular space (both systems will behave as capillaries of varying dimensions); and (b) the interfacial tensions (wetting ability) of the liquid with respect to the epidermis and the cell wall surfaces of guard cells, palisade cells and mesophyll cells.

A solution which will penetrate one leaf may not penetrate another whose stomata or intercellular spaces are of a different shape or size, or

whose cuticle or cell wall composition is slightly different. The choice of suitable solutions is therefore important.

### Methods

Ten ml. of each solution was held in 3 in.  $\times$  1 in. specimen tubes kept tightly corked. Drops (30-70  $\mu$ l. volume) were carefully placed on each surface of the leaf under investigation, using a glass dropping rod (brushing or stroking solutions on to the epidermis was occasionally found to cause damage to the surface, allowing a spurious infiltration). Occurrence or absence of injection was recorded after the drop had been on the leaf surface for 5 seconds. Infiltration was usually immediate, and leaving solutions on the leaf for longer periods gave misleading results in some cases, due to evaporation of volatile components of the mixture.

### Choice of Test Material

Richards (1934) pointed out the dangers of confounding leaf position with age, and the first experiments were performed to determine whether leaf age or position affected the reproducibility of results using the infiltration method.

The following solutions were used for infiltration:

- |                    |                     |
|--------------------|---------------------|
| 1. 90% iso-butanol | 10% ethylene glycol |
| 2. 70% ,           | 30% ,               |
| 3. 50% ,           | 50% ,               |
| 4. 30% ,           | 70% ,               |
| 5. 10% ,           | 90% ,               |

These solutions were applied to leaves on the main stem of well-watered cotton plants (BP52/9MB) grown in small plots. The experiment was

TABLE 1

"Resistance to infiltration,"\* and leaf area ( $\text{cm}^2$ )† of leaves of BP52/9MB cotton taken from different nodes on the main stem of plants of different ages. (Values given represent the means for 10 leaves.)

	1	2	3
Performed	23.9.57	15.10.57	5.11.57
Plant age	12 weeks	15 weeks	18 weeks
Total node No.	14.2 $\pm$ .54	16.3 $\pm$ .70	19.7 $\pm$ 1.20

Node No. from apex	Leaf area	"Resis. to inf."	Leaf area	"Resis. to inf."	Leaf area	"Resis. to inf."
1 .. ..	96.6	8.0	45.2	9.3	32.4	9.5
2 .. ..	75.4	5.0	98.1	5.0	78.9	6.7
3 .. ..	88.4	4.3	109.6	4.2	97.9	4.3
4 .. ..	101.0	4.0	119.8	4.2	114.2	3.8
5 .. ..	118.7	4.3	111.3	4.0	120.2	4.0
6 .. ..	147.4	4.7	126.7	4.2	122.1	3.6
7 .. ..	134.2	4.3	—	4.0	104.1	3.8

\* No std. error exceeded 3.5.

† No std. error exceeded 4.6.

repeated three times, successive determinations being made on plants differing in age by three weeks. In each experimental run infiltration was determined for leaves whose area exceeded 25 cm.<sup>2</sup> Ten plants were used as replicates. In Table 1 the term "total node number" indicates the number of nodes bearing, or having borne, leaves of area greater than 25 cm.<sup>2</sup> "Resistance to infiltration" represents an arbitrary score for infiltration such that if no solution injects, "resistance" is 10 units; if solution 1 only infiltrates, the "resistance" is 8 units, and if solutions 1 and 2 enter "resistance" is 6 units, and so on. Leaf area was determined from the dry weight of comparable leaves, knowing the dry weight per unit area.

A similar pattern of infiltration occurred on each of the three sampling dates, suggesting that for plants twelve weeks old or more, position had little effect on "resistance to infiltration." Leaf age, however, is an important factor, since young leaves with relatively small leaf area invariably showed a higher "resistance to infiltration" than other leaves. Anatomical investigation showed that for young leaves both stomatal apparatus and intercellular spaces were not fully developed. The low infiltration is apparently associated with this. Leaves from the third node down gave consistently similar results and such leaves were used for routine determinations of stomatal "aperture." (Fully expanded leaves from both monopodial and sympodial branches also gave similar results, and in some experiments leaves from such branches were used.)

### The Choice and Comparison of Infiltrating Solutions

Choice of a suitable series of solutions for infiltration is important, and a number of organic liquids in various combinations and concentrations have been used. From preliminary investigations it was found that only two series showed promise, and a number of experiments comparing these were performed. Series A consisted of mixtures of ethylene glycol and iso-butanol (Schorn, 1929), and Series B of mixtures of xylol and liquid paraffin (Alvim and Havis, 1954). For each series the proportions of the component solutions were varied in steps of 10% (*i.e.* 90% X and 10% Y, down to 10% X and 90% Y).

In comparative experiments, using cotton plants similar to those for which data for Table 1 were obtained, it was found that the two series of solutions gave entirely different results (Table 2), and that the standard errors for Series A were somewhat lower than those for Series B.

TABLE 2

Comparison of "resistance to infiltration" of cotton leaves to two different infiltrating agents on three occasions. Porometer values are also included. (See text for further details.)

Occasion	Series		Porometer resistance (in arbitrary units)
	A	B	
1. 9 a.m. 14/11/57	.. ..	4.4±0.1	4.3
2. 12 noon 15/11/57	.. ..	3.7±0.04	4.1
3. 3 p.m. 13/11/57	.. ..	2.2±0.04	2.2

In these experiments comparisons were also made with values of total leaf resistance as measured by a Wheatstone bridge porometer (Heath and Russell, 1951) with detachable cup fitted on to the leaves of plants growing in pots nearby. Series A gave results which resembled most closely the porometer results. In further experiments, Series B was found to give persistently anomalous and poorly reproducible results which were apparently associated with the use of xylol, since when this was replaced by *n*-dodecane in the paraffin mixtures (Alvim and Havis, 1954) very much better results were obtained. Mean values of "resistance to infiltration" under comparable conditions were:

- (i) *n*-dodecane/paraffin  $3.5 \pm 0.19$  units.
- (ii) iso-butanol/ethylene glycol  $4.8 \pm 0.21$  units.

Only a small quantity of *n*-dodecane was available at this time and experiments using this liquid were discontinued, remaining experiments being performed using iso-butanol/ethylene glycol mixtures.

#### Comparison of Infiltration and Porometric Methods

The relation between "resistance to infiltration" and the actual aperture of the stomata is not known. A "resistance to infiltration" of 5 units with Series A does not imply that the stomata are 50 per cent open, nor a "resistance" of 10 units that they are closed. Oppenheimer and Mendel (1939) claimed that pure iso-butanol would not penetrate orange tree stomata with small apertures. Originally it was planned to calibrate infiltration results using Lloyd's epidermal strip method (1908), but in practice it was found impossible to strip the epidermis rapidly off leaves of BP52 cotton and these attempts were abandoned. Instead, infiltration results were compared with estimates of leaf resistance using the Wheatstone bridge porometer. Plants of BP52/9MB were grown in dung and topsoil mixtures held in polythene bags (Logan and Coaker, 1957). The plants, kept in a well-ventilated greenhouse, were well supplied with water and were used when between six and eight weeks old. A porometer cup with a washer of 35 per cent gelatine dissolved in glycerol/water was quickly and carefully attached to a fully expanded leaf and an estimate of the leaf resistance obtained (handling did not apparently alter stomatal aperture as determined by infiltration). The cup was then removed and the leaf subjected to the infiltration technique. (In these experiments Series A was used with pure iso-butanol also included as a test solution. When pure iso-butanol failed to penetrate, "resistance" was considered to be 1 arbitrary unit.) Comparisons were carried out on a total of 58 leaves over the period of a fortnight under a range of light intensities from complete darkness to strong tropical sunlight. Results are given in Fig. 1, where a linear regression accounting for 79 per cent of the variation encountered has been fitted.

Professor O. V. S. Heath has pointed out that with a single infiltration value, porometer resistance may vary by a factor of more than 2, which is considerable in view of the fact that the whole range of porometer readings is rather small (less than  $50 \times$  for the extremes and less than  $7 \times$

for the mean values). The values for infiltration cover a range of leaf resistances rather greater than might be imagined from a value of the correlation coefficient of + 0.89.

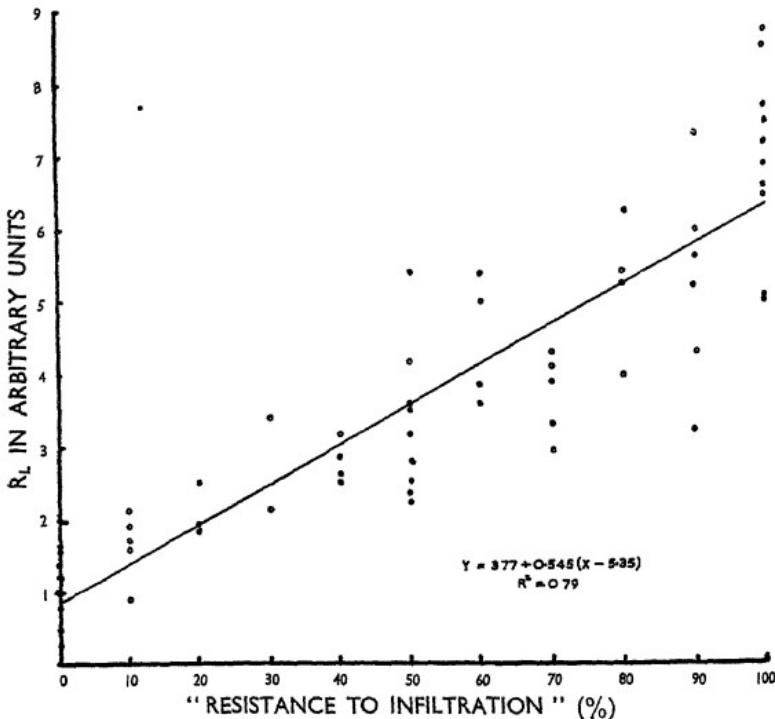


FIGURE 1. THE RELATIONSHIP BETWEEN LEAF RESISTANCE MEASURED POROMETRICALLY ( $R_L$ ) AND "RESISTANCE TO INFILTRATION," USING ISO-BUTANOL/ETHYLENE GLYCOL AS INFILTRATING AGENTS.

It should be emphasized that this comparison was made for leaves of plants growing under conditions with plentiful water supply, and values of relative turgidity of the leaves (Weatherley, 1950) always exceeded 90 per cent. The effects of prolonged periods of water stress on leaf resistance are at present unknown, but such conditions may affect surface resistivity of the mesophyll (Heath's (1941) factor "m"). It is also possible that severe water strain may affect the chemical nature of the epidermis or cell wall constituents, or effect a wrinkling of the cuticle causing a different response to infiltration. The relationship shown in Fig. 1 should therefore be regarded with caution.

#### Microscopic Examination of Stomata

Stomatal aperture in isolated cotton leaves was observed using a microscope with  $6 \times 15$  eyepiece and  $\frac{1}{2}$  in. objective. To compensate for lack of cover slip, the microscope tube length was extended to give a total

length of 20 cm. using the normal drawtube and a cardboard tube added to that. Leaves were placed on the microscope stage and left there in the dark for about three hours. The stomata were then examined and the aperture noted. Attempts were then made to infiltrate the leaves using 100 per cent iso-butanol. Results are summarized below:

<i>Stomatal state</i>	<i>No of cases</i>	<i>Infiltration with 100% iso-butanol</i>
Apparently shut .. .. .. ..	5	yes
Apparently shut .. .. .. ..	4	no
V. slightly open .. .. .. ..	4	yes

Too much emphasis should not be placed on these results, but it appears that pure iso-butanol can penetrate cotton stomata with small apertures, and that Oppenheimer and Mendel's criticism is not valid for cotton plants.

### Acknowledgments

It is a pleasure to acknowledge the interest shown in this work by Professor O. V. S. Heath, who also made several helpful suggestions on presentation.

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Received June 1958.

## COTTON PIECE GOODS IN NIGERIA\*

THE trade in cotton piece goods is virtually as old as Nigeria's contact with the outside world. The first imports probably came in across the Sahara by way of the immemorial camel trains from North Africa, the Sudan and the Middle East, and reached Nigeria through Kano, Yerwa (Maiduguri), Sokoto and other ancient trading centres in what is today the Northern Region of the Federation. Later, as the areas fringing the Bight of Benin and the Bight of Biafra were gradually opened up by the maritime nations of Europe, trade goods, including cotton textiles, were brought in through the coastal towns. Nowadays, all imports of cotton piece goods enter through the main sea ports, whence they are distributed through established trade channels to consumers throughout the length and breadth of the country.

As might be expected, the rapid rise in the standard of living since the second World War has been reflected in greatly increased imports of textiles, but although cotton goods have played their part in that overall increase, they by no means account for the whole of it. Indeed, in the last two years their popularity has shown a marked decline in favour of textiles woven from man-made fibres and particularly rayon goods, and this in spite of a reduction in the average prices of cottons since 1952, when values were at their highest.

While the figures in Table 1 indicate that imports of cotton piece goods have increased in recent years, they also show that the pattern of trade has been decidedly erratic. There are a number of factors responsible for this:

- (1) Fluctuations from season to season in the size of Nigeria's major export crops. If the surplus available for export is expected to be large, the major firms usually anticipate the consequential demand for imported goods by stepping up their imports in advance of the main produce season. If in the event the season falls below expectation, the result is an overstocked textiles market and imports the following year are reduced accordingly.
- (2) The difficulties of supply during the war and the shortage of supplies in the immediate post-war years kept the volume of imports at a considerably lower level than could have been disposed of had textiles been in free supply. It was not until 1952, which was also a bumper crop year, that supplies became freely available.
- (3) The impact of materials made of synthetic fibres on the cotton trade. In 1956, imports of cotton fell from the previous year's all-time record total of over 205 million square yards to less than 150 million square yards, and cottons were actually eclipsed in volume by rayons, for which a consumer preference had been steadily growing since the end of the war.

There is no doubt that the demand for cottons will persist for many

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years, but it is likely that rayons will continue to gain in popularity and to retain their ascendancy over cottons in the import statistics. Even rayon, however, is likely to lose ground to other synthetic materials such as nylon, particularly if these become more closely competitive in price.

Table 1 shows how the trade in cotton piece goods has developed and how average values have risen during the past twenty-five years:

TABLE 1

<i>Year</i>	<i>Quantity million sq. yards</i>	<i>Value £ thousands</i>	<i>Average value in pence per sq. yard</i>
1932	112.1	2,364	5.0
1937	162.4	3,989	5.9
1942*	82.6	3,309	9.6
1947	103.9	9,943	22.8
1952	205.0	24,766	29.0
1953	172.0	18,066	25.3
1954	170.1	16,488	23.3
1955	205.4	18,033	21.1
1956	149.4	14,406	23.1
1957†	149.3	14,443	23.2

\* Second World War.

† Provisional.

The types of cotton goods traditionally imported into Nigeria are bafts and drills, unbleached and bleached ("greys" and "whites"); drills dyed in the piece; prints; and coloured woven goods.

### Sources of Supply

The countries from which Nigeria currently obtains the bulk of her requirements of each of the main varieties of cotton goods are shown in Table 2. The quantity and value of imports of each type are also given:

TABLE 2

<i>Type</i>	<i>Total imports—1957</i>		<i>Principal sources of supply</i>	<i>Share of total imports by value</i>
	<i>Quantity million sq. yards</i>	<i>Value £ thousands</i>		
Greys (unbleached) ..	28.0	1,476	India	% 70
Whites (bleached) ..	40.3	3,154	U.K. India	28 23
Piece dyed .. ..	24.8	2,506	Japan U.K. Japan	13 44 23
Prints .. .. ..	31.0	4,198	India Japan Netherlands	13 39 32
Coloured woven ..	22.4	2,305	U.K. India Japan	23 62 14

### The Structure of the Trade

Cottons, whether grey or white, vary in quality and construction, but the normal average weight for both types is 4 oz. per square yard, the standard width is 36 inches and the weave is always plain. The cloth is usually made up for sale in 10-yard lengths, but 40-yard pieces are not uncommon.

Unbleached cottons are used for a great variety of purposes. In the Northern Region "grey" baft is the material most commonly bought by the peasant for his *riga* or gown. In Abeokuta it is used in an important local indigo-dyeing industry which produces an apparel fabric, very popular among the Yoruba people, called *adire*.

Bleached bafts and drills form the largest category of imports; the finer qualities are used for shirtings and for various household purposes.

Dyed drills are used almost exclusively for clothing. As the material has to withstand frequent washings and constant exposure to strong sunlight, high quality fast dyes are used and the cloth is dyed in the piece. The most popular colours are various shades of khaki and blue. Quality and price vary; weights range from 4 to 6½ oz. per square yard and the make-up for sale is in 6-yard lengths. The large towns and the populous Eastern Region are the main markets for dyed goods.

In the past, cotton prints accounted for a large proportion of the import trade by volume, and in value they are still the predominant category, but they have recently suffered some decline in popularity owing to competition from spun rayon. The prints are highly coloured and strong in character and are specially designed for the West Coast trade. Their main use is as materials for gowns and dresses. Prices vary considerably according to the number of colours in the print, the process used in printing and the quality of the basic cloth. The trade is highly specialized and the consumer expects to see a new range of designs each year. Most designs fall out of favour and are discarded after one or two seasons, but some have been known to remain in vogue for decades. The importing firms usually register their designs, with a view to preventing their competitors from pirating them.

Coloured woven piece goods embrace a variety of fabrics including poplins, pyjama cloths and heavy domestics. Recently there has been a demand for imitation striped fabrics developed from traditional designs produced on the narrow native hand looms.

### Production in Nigeria

The weaving of cloth on hand looms, using both imported yarn and yarn spun locally from Nigerian cotton, is an old established rural industry. It is known that the imagination of Prince Henry the Navigator was fired early in the fifteenth century by the accounts related to him of the "country cloths" woven in their villages by the people of what is now Nigeria. The weaving of these traditional cloths has continued from that day to this, but in these times the producers are finding it increasingly difficult to compete with the cheap, attractive, mass-produced cottons which are being imported in ever larger quantities.

Nevertheless, the old designs still have a special appeal for those who prefer the hand-made to the machine-produced article.

Nigeria has for many years been a significant world supplier of cotton lint; exports, recently running at some 30,000 tons a year, are increasing. To correct the paradoxical situation in which the raw material for an essential import is sent out of the country for processing overseas, while goods made of the same raw material are imported in the finished state, a large cotton spinning and weaving mill has recently been set up at Kaduna, the capital of the Northern Region. Though it went into production only recently, this mill will shortly be working three shifts a day, and on this basis will have an annual capacity of 12 million square yards of grey baft. The mill has been so designed that, if the prospects warranted, it could easily be extended; its enlargement is, in fact, already under consideration.

Though by far the largest unit of its kind in Nigeria, the Kaduna mill was not the first to be established. In 1949 a wholly Nigerian enterprise, the Kano Citizens' Trading Company, was formed to set up a textile weaving mill within the walls of the ancient city of Kano. This mill, which uses imported yarn, now has an output of some four hundred thousand yards a year. In 1949 also, a mill of approximately similar size was built at Mushin, on the outskirts of Lagos. It is now owned and operated by the Nigerian Spinning Company, also an entirely Nigerian enterprise, and is equipped with spinning machinery as well as with looms. In 1956 this mill became the first in Nigeria to weave cloth from yarn spun in Nigeria from locally grown cotton.

### The Future

It has already been mentioned that imports of rayons have been steadily overtaking imports of cottons. The following figures illustrate the change in consumer preference for the two types of material:

		<i>Million square yards</i>			
		1954	1955	1956	1957*
Cotton piece goods	.. ..	170	205	149	149
Rayon piece goods	.. ..	84	105	158	150

\* Provisional.

Perhaps the greatest fillip to the growth of the trade in textiles has come from the post-war upsurge of national feeling exemplified by the popular reversion to the wearing of traditional native dress. Where they have not replaced them, robes and wrappers now supplement European-style suits and dresses. Native dress for a man requires from 6 to 15 yards of cloth and for a woman from 6 to 12 yards, depending on the style. For ceremonial occasions—a wedding, a birth, the opening of a newly built house—which may at times affect the whole family in the widest sense of that term, it is not unusual for everyone present to be dressed in clothes of the same pattern and material. The effect of this custom on the consumption of textiles will be readily appreciated.

As the standard of living rises and the purchasing power grows, more and more people come to acquire the feeling that variety in their dress is not a luxury but a necessity: where a man or woman made do with a single cloth or wrapper in the past, it is now usual to be equipped with a multiplicity of garments of different designs and qualities to suit workaday or special occasions. With more attention also being given to household furnishing, there is a greater demand for cotton textiles for a much wider variety of purposes than was ever contemplated only a few years ago.

Even so, the 34 million people of Nigeria at present consume in an average year little more than a total of 300 million yards of all kinds of textiles for all purposes—less than 10 yards a head. It would not, therefore, be rash to assume that, so long as there is no falling-off in the present level of prosperity, the demand for textiles will continue to grow. Cotton may be surpassed in popular favour by newer and in some ways more efficient materials, but it will continue to have many uses for which other fabrics are less suitable. It may yet come back into its own.

## REVIEWS

GENETICS AND THE IMPROVEMENT OF TROPICAL CROPS. AN INAUGURAL LECTURE. Sir Joseph Hutchinson, C.M.G., Sc.D., F.R.S. Cambridge University Press. 1958. Price 3s. 6d. net.

Although the title of this lecture confines the discussion to tropical crops, there is much which impinges on plant breeding in general and reference is made to temperate species for the purpose of emphasizing important parts of the arguments. In effect Sir Joseph gives a most stimulating discourse on the relation between genetics and crop improvement, a subject of perpetual interest and controversy among plant breeders, while illustrating what he calls "two fundamental propositions in the application of genetics to crop-plant improvement," viz. the management of variability and the definition of objectives. It would be difficult to imagine a happier setting for such a lecture, given as it was by such an eminent authority at the School of Agriculture, Cambridge, where crop-plant breeding and genetics were studied so successfully over forty years.

Although Sir Joseph's thoughts on plant breeding and genetics are deep rooted in the genus *Gossypium*, on which he has made such valuable contributions to knowledge and to practical breeding, he is able to call on a wide and varied experience of tropical crops in various parts of the world, while he is fully conversant with the history and recent developments in work on temperate crops. No plant breeder is likely, therefore, to dissent from the importance of the main thesis of the lecture and its significance to plant breeders of all crops. There would be general agreement, for example, on the view that genetic knowledge can contribute essential information on which breeding programmes can be planned and techniques devised. Again, genetics and plant breeding are on common ground in considering the origin, distribution and availability of genetic variation, as well as the relationships between genetic variability (and uniformity), population size and selection pressure.

The fundamental and practical problem in crop-plant breeding is the efficient exploitation of genetic variability in the synthesis of improved stocks for the use of grower and consumer. As to how far "naturally occurring variation" or the "genetic diversity of natural populations" can be used depends on one's interpretation of these terms, as well as on the reproductive structure of the species concerned. Hybridization and selection are the plant breeder's most effective tools for crop improvement, and the mode of utilization of these techniques must depend, as Sir Joseph points out, on the reproductive structure and the distribution of genetic variability within and between species, while one could also add on phylogeny and taxonomic relationships. But Sir Joseph lays the greatest stress on the distinction between species which are self-pollinating and those which are cross-pollinating in affecting the breeder's scope for continued improvement, because of the vital importance of an out-pollinating mechanism in ensuring gene interchange and the maintenance of genetic variability, associated with rapid evolutionary change. In contrast, inbreeding, it is maintained, although quickening the tempo of the isolation of improved stocks, leads to the inevitable decay of variability and the limitation of progress that can be achieved by the breeder.

Sir Joseph develops this argument further, and illustrates the position

in some crops such as tomatoes, wheat, peas and *Phaseolus* beans, where there appears to have been a change from a significant amount of out-pollination in the original areas of cultivation, to virtual complete self-pollination in some centres of cultivation such as Europe. In the case of the tomato it is maintained that "the development of inbreeding was an accident associated with its spread into new areas," and it is concluded that self-fertilization is "a recent, and unfortunate, accident" in the history of species now showing this phenomenon.

These views are so far-reaching and open to debate that they are worthy of the most serious consideration from the point of view of several aspects of biology, as well as by the plant breeder. It is certain that some breeders of self-pollinating crops who are blessed with species or groups of species with a vast amount of genetic variation might not agree, unless the longest view in terms of evolutionary time were considered. But Sir Joseph is primarily concerned with the conservation of genetic variability, which he feels must be the basis of future progress, and he pleads for more attention to the genetics of cross-pollinators, while expressing the view that we have "far too long based our plant breeding ideas on experience with the naturally self-fertilized crop plants." It is certainly true that the breeding of cross-pollinators needs much more intensive work, and more effort should be spent on the genetics of these crops, while the dominating position achieved by the "hybrid corn" school should be examined in the light of the recent work on self-propagating varieties which would be a practical possibility for large areas in Africa where hybrid corn is scarcely applicable.

Sir Joseph has some very pertinent observations on selection methods and on the necessity for definite objectives in plant breeding. Judgment, foresight and single-mindedness are qualities which are necessary for success in all research work, and Sir Joseph pinpoints these as requirements for worthwhile improvements in crop breeding. It is important to have a definite specification to work to in selection, but to do this there must be a clear understanding of the crop-environment relationships. The interesting and important work conducted on cotton at Namulonge in Uganda with reference to climate and the physiology of the cotton plant, with special reference to crop water use, has indicated how yields might be increased by the selection of a type of cotton plant which develops a high leaf area during the time of adequate soil water availability to cope with the needs of plant transpiration. It is concluded that the life cycle of the cotton plant can be more efficiently exploited to produce higher yields under Uganda conditions by breeding types which either produce their first flowers late, or which have a greater development of vegetative branches. A combination of both characters would, of course, achieve the desired result.

The importance of this ecological and physiological approach to plant breeding cannot be denied as it must be the basis of crop adaptation and yield. It is, perhaps, not quite fair however to state, as Sir Joseph does, that "the predominant successes of plant breeders have been in such fields as disease and pest resistance and in the improvement of the more straightforward morphological characters such as length and stiffness of straw." There is evidence, surely, that the yield of cereals has been increased in some countries independently of disease resistance, and that this increase is separate from improvement in straw characters. On the other hand, it must be admitted that the physiological basis of this increased yield is not fully understood, and selection for yield is based

very largely on a morphological model, combined with certain physiological attributes that are known to be necessary for climatic adaptation and husbandry requirements. It is nevertheless true, as the purport of this lecture emphasizes, that much plant breeding work is still relatively empirical, and more fundamental research is required before it can realize its potentialities in full.

As Sir Joseph somewhat cautiously concludes, the opportunities provided for the plant breeder by agriculture in the immediate future may be just as great as they have been in the past, and it rests with scientists such as the geneticist and the physiologist to exploit these opportunities. It would probably not be unduly optimistic to feel that agriculture will surely progress technologically to make ever greater demands on the plant breeder, and provide him with ample opportunities which will be matched by breeding work of greater imagination and precision based on the steadily developing scientific knowledge in the cognate sciences.

G.D.H.B.

#### COTTON ATLAS OF INDIA, 1957.

A comprehensive cotton atlas of India has recently been issued by the Indian Central Cotton Committee.

The atlas starts by showing—graphically—India's present position in the cotton world, and the acreage, production, yield per acre and consumption of cotton are compared with those of other major producing countries.

These charts are followed by a series of maps of India showing the rainfall, soils, main cotton growing areas and varieties grown, whilst information is also given on the characteristics of the main varieties and on the changing trends of recent years. Thus, the production of Indian long staple ( $\frac{7}{8}$  in. and over) has more than doubled in six years, rising from 684,000 bales of 392 lb. in 1950-51 to 1,577,000 bales in 1955-56. Production of short staple cotton ( $\frac{11}{16}$  in. and below) in the same period declined from 839,000 bales to 662,000 bales.

Details are also given of the imports and exports of raw cotton and cotton textiles, and the final section contains maps of the individual States, showing the varieties grown, the position of the research stations, markets and mills, and the cotton seed distribution centres.

The atlas should prove an exceedingly useful and rapid reference book for all concerned with the production and consumption of Indian cotton. Copies of the atlas can be obtained at a price of 15 rupees from the Indian Central Cotton Committee, Indian Mercantile Chambers, 14 Nicol Road, Ballard Estate, Bombay 1, India.

D.F.R.

## SPINNING TEST RESULTS

A BRIEF summary is given below of the main results of tests carried out recently by the Shirley Institute.

### LARGE-SCALE TESTS

	<i>Effect- ive length</i>	<i>Stelo- meter</i>	<i>Matur- ity ratio</i>	<i>Std. fibre weight</i>	<i>Count x strength</i>	<i>Tarn appear- ance</i>
UGANDA 1957-58					50s	
UPA(56)21 .. ..	42	20.2	0.84	173	2230	4
Best of 3 Albar (56)'s .. ..	39	18.5	0.925	201	1922	2
Comparison of Albar and UPA lines grown in the Namulonge progeny bulks trial. UPA is hybrid material from (MU8 × BP52 <sup>a</sup> ) × Albar 51.						
S47 (Serere) .. .. ..	42	20.3	0.845	175	2376	5
BC177 .. .. ..	40	20.3	0.83	175	2202	5
DE715/6M .. .. ..	40	19.3	0.81	170	2208	4
Varietal comparison at Serere. BC177 is B181 × BP50 <sup>a</sup> ; DE715/6M was developed from BP50 × B181 for reduced nepiness.						
SUDAN 1957-58					50s	
<i>American types</i>						
Coker 11 .. .. ..	46	25.2	0.88	177	2104	7
Wilds SUS 16/1 .. .. ..	45	24.0	0.89	172	2110	7
Coker 100 Wilt .. .. ..	40	19.6	0.975	192	1544	6
Quality comparison from Northern Province Variety Trial at Aliab. All samples were very nappy. Coker Wilt, which is, as can be seen, of lower quality, gave the high yield of 637lb. lint per acre against 455 lb. for Wilds and 421 lb. for Coker 11.						

### SMALL-SCALE TESTS

	<i>Effect- ive length</i>	<i>Stelo- meter</i>	<i>Matur- ity ratio</i>	<i>Std. fibre weight</i>	<i>Count x strength</i>	<i>Tarn appear- ance</i>	<i>Neppi- ness</i>
NIGERIA 1956-57					40s		
Range of 12 new derivatives { of 26J	38 to 36	19.3 to 18.0	0.96 to 0.895	185 to 221	2101 to 1854	3 to 4	B to C
Small bulks test comparing new derivatives of 26C/479-25 (=26J) material in a replicated experiment. Most of the yarns were fairly good in appearance and fairly free from nep.							
Av. of 5 26C/479 .. ..	36.8	19.2	0.830	206	2107	3.2	C
Av. of 7 26C/4940 .. ..	34.7	16.5	0.985	209	1600	3.5	B
Av. of 6 26C/49160 .. ..	36.5	19.8	0.859	208	2117	2.1	B
26C .. .. ..	35	18.2	0.845	223	1803	4	B
26J .. .. ..	34	19.0	0.825	219	1847	5	D
Best 26C/49160 .. ..	37	21.3	0.885	197	2234	1.5	A
Comparison of progeny lines of 26C derivation. The 49160 family has shown up well.							

SUDAN 1957-58					40s		
<i>American types</i>							
Av. of 7 vars.—roller ginned ..	36.8	20.8	0.701	192	2251	4.3	D
Av. of 7 vars.—saw ginned ..	35.5	19.9	0.682	193	2117	5.1	E
Av. of 2 BAR 7/8.1 .. ..	34.5	18.8	0.707	186	2109	4.2	D
Av. of 2 BAR 7/8.2 .. ..	37	19.8	0.700	181	2214	5	E
Av. of 2 BAR 11/7 .. ..	36	22.2	0.642	189	2442	4.5	D
Av. of 2 Wilds SUS 16/1 .. ..	41.5	22.5	0.64	197	2364	6	E to F

Comparison of varieties and relative merits of roller and saw ginning. American types grown under rainfall at Abu Gubeiba.

## SPINNING TEST RESULTS

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	<i>Effective length</i>	<i>Stelo-meter</i>	<i>Maturity ratio</i>	<i>Std. fibre weight</i>	<i>Count x strength</i>	<i>Yarn appearance</i>	<i>Neppliness</i>
<b>SUDAN 1957-58</b>							
<i>American types</i>							
BAR 7/8.2 (Av. of 3) ..	37.3	22.6	0.663	177	2035	7	F
BAR 11/7 (Av. of 2) ..	36	24.0	0.75	170	2292	5	E
Hopi Acala (Av. of 3) ..	35	27.3	0.856	163	2166	6.3	E to F
Wilds SUS 16/1 ..	41	26.4	0.695	171	2257	7	F
Best $F_2$ of:							
BAR 11/7 $\times$ Hopi Acala ..	38	30.8	0.765	157	2584	7	F
BAR 7/8.2 $\times$ Hopi Acala ..							
(a) Kadugli ..	34	26.1	0.95	157	2260	5	F
(b) Shambat ..	40	27.6	0.71	161	2679	7	F
Wilds SUS 16/1 $\times$ BAR 11/7 ..	39	25.9	0.765	173	2603	4	D

3 incomplete blocks testing transfer of intrinsic fibre strength from Hopi Acala, and 1 replicated plot of Wilds SUS 16/1, BAR 11/7 and their  $F_2$ s, testing transfer of yield through boll weight.

	<i>Aden 1957-58</i>	<i>80s</i>
Abyan Control .. .. ..	51	27.1
AB-1 .. .. ..	50	28.2
AB-3 .. .. ..	49	27.7
BAR XL1 .. .. ..	51	27.2
BAR XL3 .. .. ..	50	26.9
K1 .. .. ..	50	27.2

Variety trial testing improvement of selected material. Abyan Control is rogued material from Sudan X1730A, from which AB1 is bulked selections and AB3 the second bulk filter. BAR XL1 and BAR XL3 are first and third filters of Sudan BAR X1730L and K1 is the first bulk filter of BAR XL1.

	<i>Nyasaland 1956-57</i>	<i>40s</i>
CLB control .. .. ..	38	20.6
CL20 .. .. ..	38	20.8
A637 (Albar 51) .. .. ..	38	21.4
Range of 8 Albar 49 .. .. ..	40 to 38	21.8 to 0.94 to
$\times$ BP52 $\times$ CL20 .. .. ..	38	20.4
AC31 (Albar 49 $\times$ CL20) .. .. ..	39	21.3

Trial of Albar 49 crosses, at Makanga (saw ginned). A637, a high yielding strain, is being multiplied for general distribution in Nyasaland.

	<i>Nyasaland 1957</i>	<i>B</i>
CLB .. .. ..	38	20.9
A637 .. .. ..	39	19.5

From variety trial at Makanga (roller ginned).

Best flood land .. .. ..	39	21.2	1.035	172	2239	2	B
Best dry land .. .. ..	38	19.3	1.035	184	2000	3	B
Medium dry land .. .. ..	36	19.4	0.97	184	1833	4	C

Three samples of roller ginned CLB from African gardens at Karonga, to compare lint grown on seasonally flooded and non-flooded land.

	<i>Uganda 1957-58</i>	<i>40s</i>	<i>80s</i>
Original bulk .. .. ..	40	19.6	0.885
Range of 12 selections .. .. ..	41 to 39	22.2 to 19.8	0.895 to 0.805

Comparison of BP52 selections, grown at Namulonge.

Albar 1MB .. .. ..	40	19.4	0.93	208	1908	3	B
Best of 5 selections .. .. ..	43	21.5	0.955	207	2203	2	B
UPA 1MB .. .. ..	40	18.5	0.805	199	1944	3	C
Best of 5 selections .. .. ..	40	21.5	0.715	207	2235	3	B

Comparison between selected Albar and UPA progenies.

	<i>St. Vincent 1957-58</i>	<i>80s</i>
Range of 6 V135 samples .. .. ..	63 to 61	32.3 to 31.3

Six samples of V135 progeny raw material grown for selection and further multiplication.

## COTTON PRODUCTION ESTIMATES

TERRITORIES IN WHICH CORPORATION STAFF ARE WORKING  
(Bales of 400 lb.)

Territory	Harvest completed	1957	1958
Uganda .. .. .. .. ..	March	372,433	350,800
Kenya .. .. .. .. ..	March	7,959	11,500
Tanganyika:			
Lake Province .. .. .. .. ..	August	151,322	138,000
Other Provinces .. .. .. .. ..	November	16,400	22,500
Nyasaland .. .. .. .. ..	August	7,000	8,500
Nigeria .. .. .. .. ..	February	143,500	244,000
Sudan Republic:			
Egyptian "S" and "L" .. .. .. .. ..	May	661,544	188,700
American Upland .. .. .. .. ..	February	43,101	73,000
Aden .. .. .. .. ..	May	28,300	30,000
West Indies .. .. .. .. ..	April	3,739	6,300
Total .. .. .. .. ..		1,435,298	1,073,300

WORLD PRODUCTION\*

(Bales of 478 lb.)

	Season 1957-58	% of total
United States .. .. .. .. ..	10,900,000	27.3
Mexico .. .. .. .. ..	2,085,000	5.2
Argentina .. .. .. .. ..	700,000	1.8
Brazil .. .. .. .. ..	1,340,000	3.4
Peru .. .. .. .. ..	430,000	1.1
Egypt .. .. .. .. ..	1,870,000	4.7
Other Africa .. .. .. .. ..	1,593,000	4.0
India .. .. .. .. ..	4,300,000	10.8
Pakistan .. .. .. .. ..	1,350,000	3.4
Syria .. .. .. .. ..	460,000	1.2
Turkey .. .. .. .. ..	600,000	1.5
Europe .. .. .. .. ..	650,000	1.6
U.S.S.R. .. .. .. .. ..	5,800,000	14.5
China .. .. .. .. ..	6,500,000	16.3
Others .. .. .. .. ..	1,288,000	3.2
World total .. .. .. .. ..	39,866,000	100.0

\* From International Cotton Advisory Committee.

## ABSTRACTS

### COTTON IN AFRICA

#### Egypt

**203.** The official August estimate of the area under cotton for the 1958-59 crop was as follows:

<i>Varieties</i>	<i>Feddans</i>
Isis (Giza 45) .. ..	3,268
Karnak .. .. ..	521,490
Menufi .. .. ..	609,810
Lotus (Giza 47) .. ..	11,719
Giza 30 .. .. ..	49,658
Dandara .. .. ..	98,562
Ashmouni .. .. ..	609,466
Others .. .. ..	976
 Total .. .. ..	 1,904,949

The total area exceeds last year's acreage by about 6 per cent., the increase in Menufi, which has been nearly doubled, having been made largely at the expense of Karnak and Giza 30. Crop progress is reported to be generally satisfactory.

#### Sudan Republic

**204. 1957-58 Season.** The June Cotton Progress Report issued by the Ministry of Agriculture gives the final estimates for acreage and yield compared with the final figures for 1956-57 as follows:

	1957-58		1956-57	
	<i>Feddans</i>	<i>Kantars</i>	<i>Feddans</i>	<i>Kantars</i>
Sakel types ..	495,321	767,050	574,712	2,688,712
American irrigated ..	11,590	25,551	11,564	27,881
American raingrown ..	194,478	267,150	149,703	144,841
Total .. ..	701,389	1,059,751	735,979	2,861,434

This yield is equivalent to approximately 261,000 bales (400 lb.) as compared with last year's record yield of 704,645 bales.

**1958-59 Season.** Rainfall in the Gezira area this season has been promising so far, and sowing prospects for the coming crop are good.

The Sudan Government has announced that the present estimate of the cost of the full extension of the Managil scheme for increased cotton growing is just under £36,500,000, or £787,920 more than was estimated a year ago. The 1958-59 budget provides for completion of the first two phases of the extension. When completed it will add some 800,000 feddans, of which about 267,000 will be under cotton each year, to the irrigated area of the Gezira.

A bill is to be presented to the Sudan parliament in its next session, for the formation of a cotton marketing board to deal with the sale of both Government and Private Estates cotton.

Experiments are being continued on the uprooting of the cotton plant after harvest by machinery and thereafter in processing the fibre for fuel and for the manufacture of a coarse material useful in making wallboard for building.

#### French Equatorial Africa

**205. 1957-58 Season.** Cotton production is estimated at 160,000 bales (500 lb. gross), which is slightly more than the 1956-57 harvest, the increase being attributed to favourable weather throughout the season. Most of the crop is grown in the northern part of the country where there is a more pronounced dry season, about 65 per cent. being produced in Tchad Province, and the remainder in Oubangui-Chari. In the past all cotton produced in the territory has been exported, but it is reported that two small cotton mills have now come into operation and are expected to use a total of 2,000 bales annually.

**1958-59 Season.** The commercial Allen variety now grown throughout the Tchad area is to be replaced by Allen 150 and 151. These new strains yield 10-15 per cent. more seed cotton than commercial Allen, and have a ginning outturn of 37 per cent. as compared with 29 per cent. for the old variety.

#### British West Africa

**206. Nigeria. 1956-57 Season.** The Northern Regional Marketing Board in their third annual report state that sales of the total Northern Province crop, amounting to 142,557 bales of lint (400 lb.) and 47,009 tons of cottonseed, realized a small surplus of £124,993, the surplus for the previous year being £341,185. By the end of October, 1957, all the crop with the exception of about 4,000 bales had been sold at an average f.o.b. value of 27·26 pence per lb. N.A.1 basis, which in general equalized the price paid to the grower plus marketing expenses. Although the total declared purchases of cotton were lower than in the previous two seasons, the proportion of Grade 1 cotton purchased was 20 per cent. more than in 1954-55 and 10 per cent. more than in 1955-56. The general improvement in grade is shown as follows:

Season		% N.A.1	% N.A.2	% N.A.3
1954-55	..	63	28	9
1955-56	..	73	19	8
1956-57	..	83	13	4

According to the third annual report of the Western Regional Marketing Board the 1957 crop yielded 2,269 bales of lint and 999 tons of cottonseed. Average f.o.b. prices were about 22·81 pence per lb. for lint and about £25 per ton for cottonseed. There was a considerable increase in marketing costs and the Board's 1957 cotton trading operations resulted in a loss of £5,096. Producer prices are shown in comparison with those paid during the past three seasons as follows:

	Pence per lb. seed cotton at all markets			
	1957	1956	1955	1954
I.N.1 .. .. ..	5·75	5·75	6·25	6·00
I.N.2 .. .. ..	5·50	5·50	6·00	5·75
I.N.3 .. .. ..	5·00	5·00	5·50	5·50

The total tonnage of Ishan seed cotton purchased for export amounted

to 1,434 tons in 1957 as compared with only 1,053 tons in 1956. A further noteworthy improvement was recorded in the quality of seed cotton marketed in 1957 as compared with the standard attained in 1956. For the first time since the revival of cotton production for export in 1954, 10 tons of Grade I quality cotton were purchased, and the quantity of Grade II cotton increased from 1 ton in 1956 to 11 tons in 1957.

*1957-58 Season.* It is estimated that the total production available for export from the whole of Nigeria during this year will be about 225,000 bales N.A. cotton, of which 80 per cent. is expected to be N.A.1 "A" or N.A.1 "B," and 15 per cent. N.A.2 "A" or N.A.2 "B." Nearly 100,000 bales have already been sold.

Adjustments have been made to the c.i.f. terms under which Nigerian cotton is offered for shipment by the Nigerian Produce Marketing Co. Ltd., London. Cotton is now being offered to buyers domiciled in England, equal in all respects to one or other of a range of new types which are readily identifiable with the qualities previously offered for sale by the company. Cotton not equal to the type sold has to be taken with an allowance mutually agreed or settled by arbitration in Liverpool based on an official scale of differences. These new arrangements should prove attractive to buyers both at home and abroad, as purchases based on physical types give the buyer better assurance regarding quality outturns than those made purely "on description." Overseas firms can obtain copies of the new types from any member of the United Kingdom handling Nigerian cotton.

**207. Progress Reports from Experiment Stations, Northern Nigeria, Season 1956-57.** (Emp. Cott. Gr. Corp., 1958.) *Plant Breeding, Agronomy and Crop Physiology.* H. E. King and D. A. Lawes. The territorial crop was heavily reduced by poor rainfall and adverse weather, but results from experimental plots showed that with the higher yielding 26J strain, timely planting, and the use of fertilizers, the effects of bad weather could be considerably lessened. Variety trials confirmed the superiority of 26J over 26C in earliness and yield. Imported types tested for increased yield gave disappointing results. Mulching experiments carried out with the object of studying the limiting effect of soil texture and surface impermeability on the use of fertilizers showed that a good response could be obtained from a heavy surface mulch of groundnut shells. Under the prevailing conditions of low rainfall, a 14 per cent. yield increase was obtained from cross-tying furrows.

*Plant Pathology.* H. M. Parker. Throughout the season disease was not particularly severe. The three main lines of investigation into bacterial blight were the relative importance of the methods of survival from one season to the next, varietal reactions to infection and the effect of seed treatments. Trials showed that unweathered trash from a diseased crop of the previous year was a potential hazard to the following cotton crop even when the seed was treated before sowing. Tests of imported varieties which are considered disease resistant under local conditions proved them to be as susceptible as the established Nigerian strains. Results from the seed treatment trials were confused by the spread of secondary infection, but seed which had been treated with Agrosan GN5 showed that the efficiency of disinfection was unaffected by the state of the seed, the site, or the time of planting.

*Entomology and Insecticide Trials.* M. A. Choyce and M. G. Emsley. The incidence of insect pests was, in most areas, comparatively light,

but in the Riverain provinces cotton stainers and bollworms were important factors in reducing yields. The mirid sampling technique developed at the Samaru Station showed that *Campylomma* populations of approximately 150,000 per acre were present during October. Trials combining the effects of date of sowing and insecticide treatments showed that the best yields were obtained from plantings between June 15 and July 31, with the greatest percentage increases from DDT and BHC treatments resulting from spraying through August. At Mokwa, where stainers are largely responsible for the low yields and poor quality of cotton obtained, spraying was more effective, and in one instance increased the yield from 455 lb. seed cotton per acre to 1,483 lb.

### **British East Africa**

**208. Kenya. 1957-58 Season.** The report of the Department of Agriculture quotes the official prices paid to growers for the 1957-58 cotton crop as follows:

Cents (E. African)* per lb. seed cotton			
Coast Province		Nyanza Province	
AR .. .. ..	60	57	
BR .. .. ..	20	22	

\* 1 E. African cent = .12d.

Although the standard of cultivation was poor in Nyanza Province generally, good results were obtained from dusting with BHC and DDT on selected holdings in South and Central Nyanza. In the Coast Province the jassid resistant variety Uk51 has replaced N17. Trials with Uk55 also showed satisfactory jassid resistance.

Trials of cotton planted on tied ridges showed no increase in yield over cotton planted flat. Spacing at 3 ft. x 1 ft. 6 in. produced a yield increase of 18 per cent. over 3 ft. x 3 ft. spacing. Although less marked differences were shown between early and late planted cotton this season than last, the same trend in favour of reasonably early planting was observed.

**1958-59 Season.** Preliminary reports from the cotton growing areas showed that the campaign for early planting was meeting with some success, especially in south Nyanza, where the crop expectation is 3,000 bales compared with 1,000 bales last season. Under normal weather conditions, a provincial crop of 10,000 bales is expected against 9,000 bales last season.

**209. Progress Reports from Experiment Stations, Kenya, 1956-57.** (Emp. Cott. Gr. Corp., 1958.) *Nyanza Province.* M. S. Hastie and T. J. Crowe. Late planting due to unfavourable weather led to decreased yields per acre. Variety trials showed no significant differences in seed cotton yields between the new strain DE715/6 and S47, but the improved disease resistance and yarn appearance of DE715/6 tend to favour its replacing S47 in Central and Elgon Nyanza.

Bacterial blight was general throughout the cotton areas. *Lygus*, stainers and bollworm were the most damaging pests, and spraying and dusting trials were carried out.

*Coast Province.* At Msabaha Station variety trials showed that the decision to change from N17 to Uk51 was sound. Other experiments were concerned with date of planting and mulching trials. The comparison of intercropped cotton with pure stand showed that the

latter made outstandingly better vegetative growth than interplanted cotton and gave a higher percentage of top grade lint.

**210. Uganda.** *1956-57 Season.* The crop realized more than £21 million, of which about £13,250,000 went direct to growers and £3,200,000 to processors, while nearly £3,500,000 was collected for export duty. The reserve fund to cushion growers against a fall in world prices held approximately £20 million.

*1957-58 Season.* Virtually final figures put the crop at 350,806 bales (400 lb.) made up as follows:

Province			AR	BR
Buganda	..	..	92,295	4,947
Western	..	..	15,016	1,064
Eastern ..	..	..	151,685	13,318
Northern	..	..	69,613	2,868
			328,609	22,197

The Lint Marketing Board have disposed of practically the whole crop, though prices dropped considerably towards the end of the season, and it is expected that approximately £2 million will be withdrawn from the reserve fund.

The total number of ginneries operating during 1957 was 135. Despite the fact that the Busoga crop was 20 per cent. less than last year, the Busoga Growers' Co-operative Union had a record season, the ginning figure of 9,330 bales easily exceeding last year's figure of 7,580 bales. The Co-operative Officer in charge of the Busoga district stated that the position may be even better next year when their third ginnery will be operating in Luzinga. This is the first ginnery to be built by a co-operative union in Uganda, and is due to be opened by the Governor in December.

*1958-59 Season.* The Agricultural Department have again launched a vigorous campaign encouraging the early breaking of land and planting. Helped by favourable weather, the campaign has been generally successful, the acreage planted to the end of June exceeding that planted during the corresponding period last season by 15 per cent. Germination is reported to be good in all zones.

In the Teso zone, which is particularly subject to *Lygus* attack, more than 1,300 spray pumps and 3,500 tins of insecticide had been sold by the end of June. Where control is effective, yield increases of 20 to 60 per cent. may be expected. In the Busoga zone plantings have been extended and the production target set at 130,000 bales in order to compensate for last season's poor crop of 85,000 bales.

**211. Tanganyika.** *1956-57 Season.* Surplus cottonseed marketed from the 1957 crop amounted to 46,300 tons.

In the Eastern Province good results were obtained through dusting cotton with BHC/DDT. Early planted cotton in Departmental demonstration plots yielded 2,850 lb. seed cotton per acre against 1,400 lb. for undusted cotton planted on the same date and 500 lb. for cotton planted three weeks later. In Kilosa District 80 cultivators purchased dust and obtained average yields of 1,031 lb. per acre against normal yields for the district of 300 to 400 lb. By the end of the year 275 cultivators had ordered dust for the 1957-58 season.

*1957-58 Season.* In the Lake Province cotton marketing opened on

June 30 and deliveries were much heavier than usual during the first two weeks, a total of 30,747 bales having been purchased compared with 10,673 bales during the corresponding period last year. This is thought to be due to the absence of disease and pests resulting in an earlier bottom crop, allied with an incentive bonus of 1 cent a lb. paid by the Lint and Seed Marketing Board to the Co-operatives for cotton bagged and delivered to the ginneries during July, ½ cent. a lb. in August, nothing in September and a penalty of 1 cent. per lb. being incurred for October deliveries. (African co-operative societies now operate thirteen ginneries throughout Tanganyika and market 60 per cent. of the crop.) The Department of Agriculture has revised the provincial crop estimate to 137,500 bales. Overall quality of the crop is good, but some cotton is rain stained and a few areas report heavy attacks of late bollworm and stainer. To the end of July the Marketing Board had sold 66,900 bales of the 1958 Lake Province crop at an average price of 200·14 E.A. cents per lb.

Estimates for the Tanga Province crop have been reduced from 3,000 to 2,385 bales.

The first large-scale irrigation scheme in Tanganyika, embracing some 5,000 acres at Mbarali in the Rufiji Basin area and estimated to cost £412,000, is being administered by the Tanganyika Agricultural Corporation as managing agents for the Tanganyika Government. It is proposed that the farm should be run for the first few years by the Agricultural Corporation in order to enable the maximum amount of technical and agricultural knowledge to be accumulated for the benefit of future schemes and for the guidance of the tenant farmers who will ultimately take over the land.

The area for the settlement scheme was readily set aside by the elders of the Sangu tribe, whose present land usage, in the form of ranching large herds of cattle over bush country, contrasts greatly with the project. On the adjoining Rujewa trial farm a most impressive range of crops is growing well under irrigation, and pioneer investigational work is being conducted concerning the irrigation potential of the soil, its fertility, and management problems. Three other small trial farms are also collating material for the Rufiji Basin Survey, which is scheduled to be completed by March 1960.

The possibility of initiating a tenant farming scheme based on cotton as the main cash crop at Kisaki on the south-east of the Ulugurus was investigated by the Agricultural Officer (Land Planning) and local agricultural staff; proposals have been made to the Tanganyika Agricultural Corporation which it is hoped will manage the scheme. A sub-station was opened to obtain agronomic data on which to base the cropping plan.

**212. Progress Reports from Experiment Stations, Lake Province, Tanganyika Territory, Season 1956-57.** (Emp. Cott. Gr. Corp., 1958.) *General Husbandry and Plant Breeding.* J. E. Peat and K. J. Brown. The Lake Province crop of over 151,000 bales constituted a record for the fourth consecutive season. Pest attack was comparatively light and the primary phase of bacterial blight was controlled by seed dressing.

In the strain trials the best district plot of Uk55 yielded over 2,000 lb. seed cotton per acre, and the mean Uk55 yield of seven plots was over 1,000 lb. as compared with 721 lb. for Mz561. December planting gave the best returns in date of planting trials. In spite of the good results obtained from the manurial trials, the general use of compost

and farmyard manure remained disappointingly low, largely because of transport difficulties under existing conditions, especially where tie ridging is practised. In the cotton breeding programme straight selection and testing of AR Mwanza material was continued. Steady increases in yield were shown for the UK strains issued successively over the past seven years.

*Soil Science.* P. H. Le Mare and A. M. Kabaara. A study was made of the quantities and movements of soil nitrate under a cotton crop on soil treated variously with sulphate of ammonia, double superphosphate and compost. The results showed good response to nitrogenous top dressings provided that sufficient phosphate was available. The relation between available soil moisture and the cotton crop was also being studied.

*Diseases.* M. H. Arnold. Hybridization programmes to increase resistance to bacterial blight were continued with Albar 51 and BAR 14/38. Seed treatments with new copper and mercurial formulations were tested. It was recommended that the rate for seed treatment with perecot throughout the Province be increased from 8 to 9 lb. per ton.

**213. Progress Reports from Experiment Stations, Eastern Province, Tanganyika Territory, Season 1956-57.** (Emp. Cott. Gr. Corp., 1958.) *Cotton Cultivation and Plant Breeding.* R. Smith. In all trials February planting and regular dusting for pest control gave the highest yields. The plant breeding programme was concerned with finding a strain with good jassid resistance, high yield and good ginning outturn, whilst maintaining the lint quality of the commercial strain 47/10. This strain is now due for replacement by Ilonga 58, which has shown average increases of 25 per cent. in yield and 2 per cent. in ginning outturn over 47/10. Results of spacing trials showed 3 feet between rows and 1 foot between plants, thinned to one plant per hole, to be the best general recommendation for all areas. Preliminary trials of cotton under irrigation emphasized the need for varieties resistant to both jassid and bacterial blight.

*Entomology and Insecticide Trials.* E. W. Valentine. Throughout the Eastern cotton areas of Tanganyika, increased production is largely dependent on widespread insecticide treatment. In general, where growers have been persuaded to adopt routine dusting, the initial outlay for material has encouraged a deeper interest in the return with resulting improved standards of husbandry. In one instance a grower achieved a yield of 2,556 lb. seed cotton per acre. In the existing circumstances it is easier for growers to dust than to spray their cotton, but on experimental plots consistently better results have been obtained from spraying, and trials were directed towards finding economies in spraying costs by varying the rates of application of DDT and BHC.

#### Central African Federation

**214. Nyasaland. 1958 Season.** A total of 3,394 short tons of Grade 1 cotton had been bought by the Agricultural Production and Marketing Board by the end of June. In the Lower River area the grade is said to be particularly good. In the Northern Province, where an average yield of 400 lb. was harvested last year, seed issues for the winter crop are about the same as for the previous season.

A cotton oil expressing mill costing £75,000 recently commenced operations in Blantyre. The mill, belonging to Nyasaland Oil Industries

Ltd., aims to express some 5,000 tons of cottonseed annually, producing 2,300 tons of cattle cake and 500-600 tons of oil.

**215. Southern Rhodesia.** In the third report of the Cotton Industries Board, covering the year 1957, it is stated that the new machines which were installed in the Gatooma Cotton Mills during 1956-57 had effectively raised production. A total of 10,729,384 lb. of cotton yarn and 565,167 lb. of absorbent cotton wool was produced as compared with 7,506,546 lb. of cotton yarn and 383,211 lb. of cotton wool during 1955. The 1957 figures were both records, as was the trading profit of £204,514.

#### South Africa

**216.** In the Barberton area bollworm infestation has spoiled what was earlier looked upon as a promising crop, and the harvest is expected to be only two-thirds of that of last season.

### COTTON IN AMERICA

#### United States

**217.** The Department of Agriculture September report estimated production for the 1958-59 season at 12,105,000 bales (500 lb. gross) with an indicated average yield of 486 lb. which, if achieved, would constitute a record.

The minimum level of price support for 1958 crop extra long staple cotton will average 53·95 cents U.S. per lb. net weight. This level reflects 65 per cent. of the current parity price of 83·00 cents per lb. for extra long staple cotton.

The Farm Bill passed by Congress contained the following major provisions.

In 1959 and 1960 farmers can choose between taking high supports and allotted acreage (A) or lower supports and an acreage increase of up to 40 per cent. over the base acreage of 16,310,000 acres (B):

1959 "A"—Supports at not less than 80 per cent. of parity, basis Middling  $\frac{7}{8}$  in.

"B"—Supports at 15 per cent. below "A" but not less than 65 per cent. of parity.

1960 "A"—Supports at not less than 75 per cent. of parity, basis Middling  $\frac{7}{8}$  in.

"B"—Supports at 15 per cent. below "A" but not less than 60 per cent. of parity.

During 1959 and 1960 the CCC will buy "A" cotton direct from the farmer, while loans, purchases and other operations will apply under "B."

Not later than January 31, the Secretary shall determine and announce—on the basis of his estimate of the "supply percentage" and the parity price as of the following August 1—the price support level for producers who elect "A" and "B" respectively, and such price support levels shall be final. The amount of cotton estimated to be produced in the additional acres allotted to producers under "B" will be taken into account in computing the support price under "A."

In 1961 and succeeding years there will be no choice of programme. The single minimum support level based on 70 per cent. of parity in 1961 will be reduced to 65 per cent. of parity in 1962 and subsequently.

Beginning in 1961, the parity base will be changed from Middling  $\frac{7}{8}$  in. to the average of the crop. This will have the effect of lowering support prices by the amount of the difference between Middling  $\frac{7}{8}$  in. and the crop average.

**218. Performance of Cotton Varieties in Texas, 1954-56.** G. A. Niles *et al.* (*Texas Agric. Exp. Sta. Bull.* 877, August 1957.) In Texas the cotton crop is grown throughout a wide range of conditions embracing climate, soils and production practices, and tests are conducted throughout the State in order to measure the performance of Upland varieties under different environments. This report includes information of Pima type American-Egyptian cotton which is grown in the arid areas of the far west under irrigation. Under favourable conditions this cotton produces a high quality fibre 1½ to 1½ ins. in length which must be ginned on roller gins to preserve the fibre quality. Pima S-1 is the only variety of American-Egyptian cotton grown commercially at this time. The cotton matures considerably later than Upland cotton and requires a long growing season. Bolls are considerably smaller than those of Upland cotton and higher picking rates must be paid. The lint percentage is low and the seed are slick. When grown out of its adapted environment, the plant often grows extremely rank, does not flower until late in the season and produces very few bolls. Under these conditions the crop is liable to severe insect damage.

Yields of American-Egyptian cotton vary considerably, depending on seasonal conditions, but are usually two-thirds to three-quarters of Upland cotton yields. Varieties are tolerant to *Verticillium* wilt and the cotton is often grown on wilt-infested soils. It is, however, very susceptible to bacterial blight.

**219. Cotton Pest Incidence in the United States in 1957.** See Abstract 241.

**220. Mexico.** Cotton production for the 1958-59 season is forecast at 2,240,000 bales (500 lb. gross). This is an increase of 7 per cent. over the 2,085,000 bales produced in 1957-58, and is only slightly below the record 1955-56 crop of 2,250,000 bales. The increase in production is the result of the second largest acreage on record, estimated at 2,425,000 acres.

#### West Indies

**221.** The report of the West Indian Sea Island Cotton Association for 1956-57 gives statistics for acreage and production in the cotton growing islands including Montserrat and St. Kitts. In his address to the Association, the President stressed the need to increase production in order to stabilize the market and meet rising competition. He suggested that yields might be increased if fuller advantage were taken of the knowledge now available through research and investigation, and drew attention to the need for more accurate crop estimation, pointing out that the present trend of inaccuracy created a feeling of uncertainty in the market and thereby weakened the bargaining power of the Association.

The individual crops harvested for the 1957-58 season are as follows:

					<i>Bales (400 lb.)</i>
Antigua ..	..	..	..	..	3,368
Nevis ..	..	..	..	..	1,242
Montserrat ..	..	..	..	..	678
St. Kitts ..	..	..	..	..	520
St. Vincent ..	..	..	..	..	460
Barbados ..	..	..	..	..	2
 Total ..	..	..	..	..	6,270

**222. Progress Reports from Experiment Stations, West Indies, Season 1956-57.** J. R. Spence *et al.* (Emp. Cott. Gr. Corp., 1958.) For the first season since 1911, cotton throughout the West Indies generally was planted in August-September. So far the change of planting date in Montserrat and St. Kitts appears to have had no effect on lint quality. Bad weather delayed planting and affected early growth in several islands, but increased acreages were reported from St. Kitts and St. Vincent.

In Antigua trials were concerned with the effects of manuring and fertilizer application, spacing and rotation. The V135 maintenance programme was continued in St. Vincent. Trials for *Fusarium* wilt resistance showed that only 6·3 per cent. of the V135 material remained wilt free at the end of the season, as compared with 96 per cent. for MSI and 99 per cent. for Seabrook. In yield trials VH10 was proved superior to VH8 and MSI.

It was noted that cotton in Montserrat and St. Kitts, following long close seasons, suffered only very slightly from pink bollworm attack, whereas heavy infestations are reported from other islands. Severe losses were also incurred locally through attacks from stainers, leafworm and *Nezara viridula*.

#### **El Salvador**

**223.** The 1957-58 cotton crop is estimated at a record 157,000 bales (500 lb. gross). This is 15 per cent. more than the 137,000 bales grown in 1956-57, and 18 per cent. above the crop for 1955-56. The increase is attributed to slightly larger acreage, continued improvement in cultural practices, and favourable weather.

99,000 acres were planted for this season's crop, and it is expected that this acreage will remain fairly constant for the next few years. Internal consumption is expected to reach 17,000 bales in 1957-58.

#### **Argentina**

**224.** The 1957-58 cotton crop, estimated at 700,000 bales of 500 lb. gross, is the largest on record, production having increased by 46 per cent. from the 480,000 bales produced in 1956-57, and 24 per cent. from the 1955-56 crop of 563,000 bales. The increase is attributed to the record acreage planted and favourable weather. The area planted, at 1,600,000 acres, was 25 per cent. above the planting for the previous season.

### **COTTON IN ASIA**

#### **India**

**225.** The 1957-58 cotton season ended on August 31. The commercial crop is estimated at 5,150,000 running bales which, added to the carryover of 1,720,000 bales, gives a total supply of 6,870,000 bales.

An improved variety named 35/1 is being recommended for growing in Uttar Pradesh. This new strain gives an additional income of Rs. 34 per acre over the established variety C.520. The yield averages 714 lb. of seed cotton and 264 lb. lint per acre. It has a staple length of  $\frac{2}{3}$  in. and a ginning percentage of 37. 35/1 was grown on 64,000 acres in 1956-57 and is expected to cover 150,000 acres under the present Indian Central Cotton Committee scheme.

In the Punjab two new strains of long staple cotton have been evolved, namely LL53 and LL54, having a mean fibre length of 1·10 in. and 1·07

in. respectively. These strains also have greater yield and higher ginning percentage than the existing commercial strain 320F. District trials with the new strains have shown an average cash return of Rs. 625 and Rs. 686, respectively, per acre, as against Rs. 608 from 320F.

**226. Length Improvement in Madras Cottons.** N. K. Iyengar and V. Santhanam. (*Ind. Cott. Gr. Rev.*, 12, 3, 1958, p. 75.) Cotton breeding research has been in progress in Madras State during the last thirty years on both the important commercial varieties cultivated, namely Cambodia (*G. hirsutum*) and Karunganni (*G. arboreum*). To date the most significant achievement of this research has been the improvement in lint quality, particularly as regards staple length. The progress in length improvement is reviewed in this paper.

**227. Indian Central Cotton Committee: 36th Annual Report, 1957.** (*Ind. Cent. Cott. Cttee., Bombay*. Price Rs. 3.) Although India has at present the largest territorial area under cotton in the world, it takes third place after U.S.A. and the U.S.S.R. as regards production. Efforts to increase the yield per acre are therefore of major importance in the Committee's research programmes. This objective is beset with many difficulties as the crop is mostly grown under rainfed conditions and production varies enormously from tract to tract and from year to year depending on season and environment. In the irrigated tracts of the Punjab and Madras, yield varies from 200 to 250 lb. lint per acre, while in the dry tracts it ranges between 60 and 100 lb.

The agricultural and physiological investigations which are being carried out in the various States and Provinces of the Union are summarized, and the extension work connected with improved cultural practices and the introduction of better varieties is reported. A comprehensive scheme for producing Andrews cotton in the States of Kerala, Mysore and Assam has been placed under a Special Officer. The scheme aims at the systematic development of large-scale cultivation of Andrews, which has a staple length of  $1\frac{1}{8}$  in. The successful completion of this scheme is expected to result in the extension of this variety to about 300,000 acres by the end of the second Five Year Plan (1960-61) with a production amounting to about 225,000 bales of lint.

**228. Technological Reports on Trade Varieties of Indian Cottons, 1957.** R. L. N. Iyengar. (*Indian Cent. Cott. Cttee., Tech. Bull.*, Ser. A, No. 96, March 1958.) This bulletin gives the test results obtained for 1956-57 growths of thirty-three commercial varieties. The data for each cotton are divided into the following categories: (1) Ginning percentage; (2) Fibre test results; (3) Grader's valuation report; (4) Spinning master's report; (5) Spinning test results which include waste losses, number of end breakages in the ring frame, actual counts spun, lea strength and ballistic work on rupture of yarn, number of turns per inch inserted in the yarn; (6) Estimation of yarn neppiness and evenness; and (7) Details of front roller speeds, spindle speeds and drafts employed. The conditions of relative humidity and temperature prevailing in the spinning and yarn testing rooms are maintained at about 65 per cent. R.H. and 85° F. respectively. Results of the past five seasons' tests are given for comparison. The test results of three varieties of East African cottons, namely AR BP52, AR Busoga and AR Jinja, are included in this bulletin, as these cottons are consumed in large quantities by the Indian mills.

The following details from the reports are compared with details of the 1956 crop.

	BP52		Busoga		Jinja	
	1956	1957	1956	1957	1956	1957
Class .. ..	Pass	2 grades above F.A.Q.	Pass	Pass F.A.Q.	Pass	Pass F.A.Q.
Colour ..	White	Pearly white	White	Creamish white	White	Creamish white
Feel .. ..	Silky	Silky soft	Silky	Soft	Silky	Soft
Staple length ..	1 $\frac{1}{8}$ "	1 $\frac{5}{8}$ "	1 $\frac{1}{8}$ "	1 $\frac{1}{8}$ "	1 $\frac{1}{16}$ "	1 $\frac{1}{16}$ "
,, strength ..	Good	Good	Good	Good	Good	Good
Regularity ..	Regular	Regular	Regular	Regular	Regular	Regular

### Pakistan

229. Pakistan's cotton acreage has stabilized at around 3.5 million acres during the last three seasons, and it seems that this will be the normal acreage expectation over the foreseeable future. However, production prospects in 1958-59 may be affected by shortage of water in the Canal area. The Sutly Valley Section, representing about 15 per cent. of Pakistan's total cotton acreage, has been seriously affected.

The pattern of trade in cotton has materially changed in recent years with the rapid growth of the local textile industry. Whereas at the time of Independence and until a few years ago Pakistan exported almost the entire crop as lint, local mills now consume more than one million bales, or 60 per cent. of the normal crop. The value of cotton yarn and cloth exported rose from Rs.17,000 in 1954 to Rs.86 million in 1957.

## COTTON IN EUROPE

### Greece

230. Cotton is developing very favourably with indications of an early harvest. The crop is expected to reach approximately 250,000 bales. The Coker 100 Wilt variety is being more extensively grown in continental Greece. A new local variety called 10E is being introduced in Macedonia. Considerable areas of Thessalia, previously cultivated with cereals, are now occupied by the cotton variety Acala 4-42. Five tons of seed of this variety was imported direct from the breeder in the United States for local multiplication. It is hoped that the expansion of production in combination with technological improvements in the character of Greek cotton will make the product more competitive in foreign markets. Within the next five years Greece will be producing 400,000 bales of fibre annually. Proceeds from the increasing output will be devoted to the extension of electrical services, the doubling of irrigated areas, and the establishment of a cotton mill and oil refinery.

## COTTONSEED, OIL AND LINTERS

231. **Cottonseed Symposium.** (*World Crops*, September 1958.) A symposium on "Cottonseed and Its By-products" will be held in

Hyderabad from December 5-7. Discussions will cover the processing and storage of cottonseed, refining of cottonseed oil, hydrogenation, solvent extraction, fundamental studies, by-products, standards, statistics and marketing data. Enquiries should be directed to the Director, Regional Research Laboratory, Hyderabad 9, India.

**232. The Standardization of Cotton Linters.** M. E. Whitten and H. R. Webb. (U.S.D.A. Mktg. Serv. Cott. Div., July 1958.) In the United States cotton linters, once considered a nuisance, have since 1910 represented from 2 to 25 per cent. of the total value of production obtained from the milling of cottonseed. The average annual production of linters has approximated 1,500,000 bales during the past few years with an average annual value during the five-year period 1952-56 of approximately 48 million dollars.

Through the past fifty years, significant changes have occurred in the varieties and linters content of cottonseed, and in the method of producing, harvesting and ginning cotton, all of which have affected the quantity, quality and appearance of the linters produced. Moreover, as the quantity of linters increased, uses for linters also increased. Early uses included padding, stuffing and twines. Consumption greatly increased with the expansion of the nitro-cellulose industry. Later uses for linters in synthetics such as rayon, plastics and similar products also increased the demand.

In 1926 attempts at classifying linters according to quality were made by some of the larger groups of cottonseed oil mills, the types corresponding to the qualities which they usually produced. As the only recognized universal means for describing quality, the standards proved valuable in production control and marketing. However, by 1950 the standards no longer accurately represented the qualities being produced. A survey of the industry was made in 1952 with the result that work was begun on the development of revised standards for linters. The standards now established consist of seven physical grades numbered 1 to 7 for felting qualities, with the remainder classified as "Chemical." Each physical grade is represented by six samples arranged in two horizontal rows of three samples each, showing the proper range of colour and trash for that grade. The samples are numbered 1 through to 6 from left to right and top to bottom. In every grade, sample 1 represents Far Western linters, which were not included in the former standards; samples 2 and 5 represent South Central or valley linters; samples 3 and 6 represent Southwest linters; and sample 4 represents Southeastern linters. This arrangement of samples provides an increasing degree of yellowness in each grade box from left to right. This was found necessary to prevent misleading contrast between adjacent samples that differ in this factor to a considerable extent.

#### SOILS, FERTILIZERS AND CULTIVATION

**233. "Mechanical Roots" — Instruments for Controlling Irrigation.** (*World Crops*, September 1958, p. 345.) Instruments known as "Irrometers" which give an exact reading of the moisture condition in the root zone of a crop are being manufactured by T. W. Prosser and Co. of the U.S.A. When used in pairs, these gauges are in effect a sort of mechanical root, which operates on the tensiometer principle.

The control of irrigation by this system is based on individual

"stations" disposed over the field, which indicate the need for water in each irrigation block. The depth of the root system of the crop determines the depth at which the gauges should be installed. For surface-rooting crops with root systems up to 18 in. in depth a single instrument is sufficient; for crops having root systems between 18 in. and 48 in. in depth, two depths per station are required—a "shallow" gauge reaching to about three-quarters of the root zone. The shorter instrument tells when it is necessary to commence irrigation, and the longer instrument indicates when irrigation should be discontinued if the leaching of fertilizer is to be prevented, thus making it possible to conserve both water and applied fertilizer by preventing over-irrigation.

**234. Preliminary Field Investigations of Electrical Resistance-Moisture Stress Relations in Cotton and Grain Sorghum Plants.**

J. E. Box and E. R. Lemon. (*Proc. Soil Sci. Soc. Amer.*, **22**, 3, 1958, p. 193.) In recognition of the need for a simple method of determining when to apply irrigation water to a growing crop, a study was made, using cotton and grain sorghum plants under field conditions, of the relation between the moisture stress in the plant stems and electrical resistance between two electrodes inserted in their stems. The results suggest that this simple electrical measurement is largely related to hydration in the plant stem tissue.

Electrical resistance measurements in cotton under various soil moisture régimes in the field demonstrated that: (a) resistance was closely correlated with soil moisture; (b) resistance measurements underwent diurnal fluctuations, but always continued an upward trend during a drying-out cycle following an initial lag after irrigation; and (c) the coefficient of variation ranged from about 10 per cent. for 8 a.m. measurements to 24 per cent. for 2 p.m. measurements, depending upon soil moisture conditions.

**235. "Stabilose"—a New Soil Stabilizer.** (*The Agric. Rev.*, **4**, 3, 1958, p. 23.) A new starch-based chemical, to be known as "Stabilose," has been introduced by W. A. Sholten's Chemicals of Groningen, Holland. The material is not intended for the permanent fixation of soil that is subject to blowing, but only to prevent wind erosion during the period when the soil is bare through cultivation. The durability of the effect varies from a few weeks to a few months, the time being largely determined by the numbers of micro-organisms in the soil; the chemical is gradually decomposed by soil organisms. The material does not check germination of seeds or the development of seedlings.

**236. Application of Emulsifiable DBCP in Irrigation Water as a Preplanting Soil Treatment.** J. H. O'Bannon. (*Pla. Dis. Repr.*, **42**, 7, 1958, p. 857.)

In the United States Southwest where irrigation is used extensively, water application has proved satisfactory for certain types of chemicals, such as fertilizers and soil conditioners. This paper describes a method of applying emulsifiable DBCP (dibromochloropropane) in irrigation water as a preplanting treatment on land infested with the cotton root-knot nematode, *Meloidogyne incognita acrita*. Results showed that the chemical moved readily with water, and when an emulsifiable concentrate of DBCP was applied at the rate of 1 gallon p.a. active ingredient the distribution and penetration were found to be reasonably uniform over rows 1,250 ft. long to a depth of at least 12 in.

**237. Cotton Improvement through Advances in Production Practices in Fifty Years.** W. L. Giles (*Agronomy J.*, **50**, 7, 1958,

p. 349.) Yield, efficiency of production, staple length and grade are used as measures for comparing the improvement in the United States cotton crop through the years 1907-56. During this period lint yield is shown to have increased 2.3 times, *i.e.* from 11.1 million bales harvested from 31.3 million acres in 1907, the average yield being 178 lb. per acre, to 13.3 million bales harvested from 15.6 million acres in 1956, the average yield being 409 lb.

The index number of man-hours of labour in 1910 was 177 compared with 63 for 1956. In 1928, 78 per cent. of the fibre measured less than 1 in., and only 16 per cent. was in the 1 in. to  $1\frac{3}{8}$  in. group; in 1954 only 29 per cent. of the fibre was below 1 in., and more than 67 per cent. was in the 1 in. to  $1\frac{3}{8}$  in. group. However, in 1928, 54 per cent. of the crop graded above Middling, and 41 per cent. was in the three grades, Middling, Strict Low Middling and Low Middling, whereas in 1955 less than 1 per cent. of the lint was graded above Middling, and 84 per cent. came within the three lower grades. This decline reflects the change from hand to machine harvesting, but the economy of the latter more than compensates for the loss on grade valuation.

Most important among the production practices which have led to increased crops are improved methods of cultivation, the use of fertilizers, mechanical and chemical weed control, effective pest control measures and mechanized harvesting. In assessing the improvements made through the past fifty years, however, recognition must be given to two factors not associated with production practices, namely, better land selection resulting from acreage control, and the movement of the crop from the less fertile soils of the Southeast to the irrigated lands of the West.

**238. Skip-row Cotton Planting in the United States.** J. B. Dick. (*Int. Rev. Cott. Allied Text Indus.*, 26, 102, 1958, p. 127.) Since 1956, when acreage reduction credit was first allowed for skip-row planting, an increasing number of farmers have found it profitable to use this method of acreage reduction on part of their cotton land with an estimated average yield increase of 20 to 25 per cent. In Arizona an average yield of 4.2 bales per acre from 795 acres (3,340 bales) has been obtained under this system.

In 1956 the Delta Branch Experiment Station at Stoneville, Mississippi, began a five-year study to evaluate the practice and to measure the effect of outside or border rows in replicated 4-row cotton—4-row fallow and 2-row cotton—2-row fallow plots with plots of solid planted cotton. The study was located on good cotton land and the planted rows were fertilized with anhydrous ammonia at 90 lb. N per acre. The unplanted rows were fallowed with a disc. In that year August temperatures were unusually high and under the prevailing conditions 4-row planted rows showed a 25 per cent. increase over solid planting at the first picking on August 29 and a final increase of 73 per cent. in total yield, the inside rows of the 4-row plots producing 16 per cent. more than the solid planted rows. The 2-row planted plots produced approximately 130 per cent. more cotton per acre than the solid planted plots. It was claimed that these yield increases were due to additional moisture from the fallowed plots and to increased sunlight and air circulation along the border rows.

In 1957, when heavier rainfall gave adequate soil moisture throughout the season, the yield increases were 25 per cent. and 45 per cent. from 4-row planting and 2-row planting respectively. Other advantages of skip-row planting are easier control of weeds and eradication of Johnson

grass, and whatever benefits are derived from fallowing land; the main disadvantage is the increased cost of production per acre. It is understood, however, that the skip-row system is profitable only on good cotton land, and for so long as the regulations governing United States cotton acreage control remain in force.

**239. Disposal of Cotton Stalks and Roots.** E. B. Williamson. (*Miss. Farm Res.*, 20, 11, 1957, p. 1.) Stalk shredding is an accepted practice in the Mississippi cotton area, but root and stubble disposal remains a problem. Field trials have shown it impractical to cut the roots before shredding, as shredders operate most effectively on firm upright stalks. The type of tillage implement ideally suited for stalk and root disposal is the rotary plough, but its adaptation is hampered by its limited speed and relatively high power requirements. At the Delta Branch Station, Stoneville, roots were satisfactorily removed from the soil by the attachment of short steel rods to the trailing edges of large heavy-duty sweeps, the action of this device being similar to that of a potato digger. In California an experimental machine has been produced which cuts the roots, pulls the stalks from the ground, shreds all plant debris and distributes it evenly in the old row middles, thereby greatly assisting subsequent land levelling operations. This machine is now being used on a custom basis. Current models include a two-row machine equipped with hydraulic depth controlled cutter blades and high-speed knives. Although considerable power is required for operation, reports on the machine's performance have been generally favourable.

In semi-arid areas where ploughing is delayed for several months the litter of shredded stalks scattered over the soil can help to reduce erosion. Elsewhere investigations are concerned with machinery that will crush and bury surface trash completely at a maximum depth as a control measure against pink bollworm.

**240. Growing of Cotton on Ridges in Reclaimed Soils.** A. G. Asghar and M. A. H. Khan. (*Pakis. J. Sci.*, 9, 5, 1957, p. 219. From *Field Crop Abs.*, 11, 3, 1958, p. 200.) In 1953 and 1954, the cotton variety 289F/43 was grown in reclaimed soils (salt content mostly below 0.2 per cent. throughout the profile and  $\text{pH } 9$ ) by the ridge and flat techniques, in each case employing normal sowing rate and spacing. In these two years yields were respectively 47 and 18 per cent. higher from ridged than from flat cultivation. The quantity of irrigation water required and the time taken to irrigate a ridged plot were half that for a flat plot. The ridge method gave a net financial gain after taking the cost of ridging into account. It is noted that ridged cultivation is not likely to prove successful in unreclaimed soils with a high salt-content at variable depths in the soil profile.

#### PESTS AND DISEASES

**241. Cotton Pest Incidence in the United States in 1957.** J. W. Gentry. (*FAO Pla. Prot. Bull.*, 6, 8, 1958, p. 118.) Boll weevil (*Anthonomus grandis*) attacks were heavy in many States. Areas in Georgia had up to 85 per cent. punctured squares and damage was heavier in South Carolina than in 1956. In North Carolina infestation of untreated cotton reached over 50 per cent., while populations were heavy and general over the southern two-thirds of Mississippi. In Alabama damage was estimated at \$12 million. Arkansas recorded

its heaviest infestations in many years, and the weevil was again the primary pest in Louisiana. Damage occurred farther north in Tennessee than it had for many years.

Bollworms (*Heliothis* spp.) caused heavy damage in California, Arizona and Nevada, and in the coastal and central areas of Texas. Pink bollworm (*Platyedra gossypiella*) attack was generally light in most infested States, but severe locally in Arizona, New Mexico and Texas.

Cotton leaf perforator (*Bucculatrix thurberiella*) was one of the top pests in Imperial County, California, where it caused damage estimated at \$1,834,900. The cotton leafworm (*Alabama argillacea*) was one of the most troublesome pests in Oklahoma, while many untreated fields in Louisiana were completely defoliated. Severe damage was reported from New Mexico and Arizona also, but in Georgia and South Carolina defoliation though heavy came late in the season and was, therefore, considered beneficial.

The heaviest infestations of cabbage looper (*Trichoplusia ni*) on record appeared in cotton in Louisiana, and Alabama reported the first important defoliation from this pest. Injurious populations appeared also in other cotton growing states. Aphids were more damaging than is customary early in the season in Arizona. *Aphis medicaginis* caused losses in areas in New Mexico and *A. gossypii* was heavier than in 1956 in Georgia, Alabama and Arkansas.

*Lygus* bugs, mainly *Lygus hesperus*, were the most considerable in Arizona and required control in most fields. In the Imperial Valley of California losses due to *Lygus* spp. were estimated at \$1,500,000. Light to severe infestations also occurred in other California areas. *L. elisus* and *L. hesperus* were extremely damaging to cotton early in the season in New Mexico.

Cotton fleahopper (*Psallus seriatus*) was very detrimental to cotton in New Mexico and, together with another fleahopper, *Spanogonicus albofasciatus*, it was abundant in Arizona. An average of 300 nymphs per 100 terminals was common in southern Texas early in the season. Spider mites required extensive controls in Kings County, California, and were light to heavy in some other areas of this State. Twice as much acreage was treated for *Tetranychus* spp. as in 1956.

**242. Cinq Années d'Expérimentation en Vue du Contrôle des Diplopodes en Culture Cotonnière.** (Five Years' Trials in the Control of Diplopods in Cotton.) P. F. Galichet. (*Cot. Fib. Trop.*, 12, 2, 1957, p. 266.) Through 1951-56 laboratory and field trials were carried out at Tikem Station in Tchad, French Equatorial Africa, to study the control of diplopods in cotton. In the laboratory tests, soil treatment with HCH at 30 kg., or aldrin at 6 kg., active substance per hectare, was effective. Field trials showed little difference between soil treatment at the rates quoted above and seed treatment at the rate of 2-3 g. HCH active substance per kg. of undelinted seed, or aldrin at the rate of 0.5 g. of active substance per kg. of seed, but emergence was 7 to 10 per cent. higher in the treated than in the untreated plots.

**243. Duration of Development of *Dysdercus fasciatus* in Dependence on Temperature and Humidity.** W. Ensslin. (*Z. Angew. Ent.*, 39, 1956, p. 28. In German with English summary. From *Rev. Appl. Ent.*, 46, Ser. A, 7, 1958, p. 246.) *Dysdercus fasciatus* was reared in the laboratory at constant temperatures of 21°-30° C. and various relative humidities, soaked cotton seeds being provided as food and moistened filter papers as sources of water, and curves are given

showing the duration of development of the egg stage and each of the five nymphal instars. The optimum temperature for the development of the fifth instar was about 27° C. at 100 per cent. relative humidity, males developing more rapidly than females, and slightly higher at 90 per cent. humidity, but the optima for the egg and other instars evidently lay above 30° C.

**244. *Helopeltis du Cotonnier en Afrique Centrale.*** (*Helopeltis* on Cotton in Central Africa.) G. Schmitz. (*I.N.E.A.C. Série Scientifique No. 71*, 1958.) This memoir of 178 pages, with plates in colour, is based on work carried out in Uele in the Belgian Congo, particularly at Bambesa. A systematic history of the genus is followed by a key and general comments on the African species, and descriptions of *H. bergrothi* and *H. schoutedeni* with notes on their distribution on cultivated plants. The remainder of the memoir concerns *H. schoutedeni*, which is one of the two main cotton pests in the northern Congo. Full details are given of its life cycle and bionomics, epidemiology, feeding habits, effects on the plant, and levels of population. The final chapter deals with indirect methods of limiting its attack, through modification of the mineral nutrition of the young plant, parasitism, and phytosanitary measures, and also with direct mechanical or chemical control. A bibliography of over 300 entries is appended.

**245. Oviposition Sites of the Pink Bollworm on the Cotton Plant.** J. R. Brazzel and D. F. Martin. (*J. Econ. Ent.*, **50**, 2, 1957, p. 122. From *Rev. Appl. Ent.*, **46**, Ser. A, 5, 1958, p. 174.) Field-cage experiments were carried out in Texas in 1955 to determine the preferred oviposition sites of *Platyedra gossypiella* on cotton plants as they developed from the four-leaf stage to maturity. Bolls appeared on the plants about June 18, but they were not numerous until after July 13. Before that date, more than half the eggs were laid on the terminals, and after it, one-third or more were deposited on the bolls; hardly any eggs were laid on the squares. The proportion laid on fruiting parts did not exceed that on vegetative parts until August 2, when the bolls were beginning to open.

Larvæ from eggs deposited on the vegetative parts early in the season have to migrate over the plant in search of food and are therefore more exposed to destruction by predators, parasites or insecticides; this may explain the slow increase in population early in the season and the rapid increase later. Although all the moths liberated in the cage were obtained from overwintered larvæ, the rate of oviposition appeared to increase as the season progressed, possibly because eggs were laid off the plants before the bolls appeared.

**246. Growth and Reproduction of the Pink Bollworm on an Amino Acid Medium.** E. S. Vanderzant. (*J. Econ. Ent.*, **50**, 2, 1957, p. 219. From *Rev. Appl. Ent.*, **46**, Ser. A, 5, 1958, p. 186.) The author describes the composition and preparation of a chemically defined medium that provided an optimum diet for the growth and reproduction of *Platyedra gossypiella* obtained by substituting l-amino acids for the casein in the medium previously used. It contained about 2 g. per 100 ml. of amino acids, of which two-thirds comprised the ten essential ones, in proportions similar to those found in cotton seeds. The amounts of other amino acids, vitamins, choline, salts and cholesterol were greater than those previously found necessary. Larvæ reared on the medium developed in normal periods and gave rise to normal pupæ and adults, and the females deposited large numbers of viable eggs. A second generation was reared in the same way.

**247. The Persistence of Insecticides on Cotton.** K. C. Sleep (Colonial Pesticides Research Unit, Arusha, Tanganyika. *Misc. Rep.* 202, May 1958.) The use of insecticides to control cotton pests has been assessed entomologically in East Africa, but neither the initial deposits on leaves resulting from a particular application rate, nor residue data, have been previously recorded. During 1956-58 the chemical persistence of emulsifiable concentrates of DDT, endrin and malathion was investigated at Urambo and Arusha in the Western and Northern Provinces of Tanganyika, respectively.

The regression of logarithm of insecticide residue on logarithm of time since treatment was linear in most experiments, and a comparison of regression coefficients showed that DDT was more persistent than endrin. Malathion was less persistent than either DDT or endrin. Rainfall caused increases in the rate of loss of insecticide residues.

A general regression coefficient expressing the rate of loss of DDT was calculated, which could be used for cotton leaves under a variety of climatic conditions.

**248. Control of Some Pests of Cotton by treating the Seed with New Types of Systemic Insecticides.** M. F. Souza *et al.* (*Biológico, S. Paulo*, 23, 12, 1957, p. 227. In Portuguese. From *Field Crop Abs.*, 11, 3, 1958, p. 202.) In a plot trial in São Paulo, Brazil, with the cotton variety I.A.C.817, several insecticides, used in mixture with the seed, were tested for controlling *Aphis gossypii*, *Tetranychus telarius* and *Hemitarsonemus latus*. Results showed that: (a) thimet, 45 per cent. active principle, in activated carbon, mixed with the seed in the proportion of 4 per cent., gave effective control (95 per cent.) of *A. gossypii* for 60 days, falling to 58 per cent. after 70 days; OMPA was slightly superior; (b) disyston, 50 per cent. active principle, mixed with the seed in the proportion of 4 per cent., gave 90 per cent. control of *A. gossypii* for 70 days; its control was still satisfactory after 100 days; (c) disyston, and OMPA to a lesser degree, gave satisfactory control of *T. telarius*; (d) no control was obtained of *H. latus*.

**249. Relation of Protoplast Permeability to Cotton Seed Viability and Predisposition to Seedling Disease.** J. T. Presley. (*Pla. Dis. Repr.*, 42, 7, 1959, p. 852.) Experiments were carried out to determine the effect of time, temperature and moisture on cotton seed, in relation to seed viability, seedling vigour and seedling disease. Seeds placed in containers at approximately 100 per cent. relative humidity were held at 15°, 20°, 30°, 40° and 50° C. Results showed that temperatures of 30° or below for 25 days did not appreciably affect viability, while at 40° for 15 days seed deterioration was evidenced by reduced germination.

The seeds placed at 50° C. and 100 per cent. relative humidity were sampled and germination tests run at daily intervals. Up to the third day seeds germinated normally, after the fourth day there was reduced germination at low temperatures, after the fifth day there was reduced germination at all temperatures, and there was practically no germination of the sixth day sampling at any temperature. Attempts to find a rapid means of measuring the degree of deterioration which would closely parallel the laboratory germination results showed that the permeability of the protoplast to electrolytes may be measured by the conductivity of distilled water leachings. The healthy protoplast allows only small quantities of electrolytes to leach through its membranes. Injury results in changes within the protoplast which alter the semi-permeable properties of its membranes. Thus seed with different degrees of injury

or deterioration may be detected by differences in conductivity of distilled water leachings.

When weighed amounts of seed were soaked in measured volumes of distilled water for periods ranging from 15 minutes to 24 hours at room temperature and at 50° C., seed of high viability consistently gave high resistance readings while seed of varying degrees of deterioration gave decreasing resistance readings commensurate with the degree of deterioration. This method of checking seed viability is extremely rapid, with fairly accurate measures of differences being possible after 15 minutes of soaking in distilled water at 50°.

Fungus growth was found to be more abundant where seed deterioration was greater, and observations led to the conclusion that seed of poor viability and low conductivity readings may be considered as predisposed to seedling disease.

**250. Influence of Fungicides, Calcium Salts, Growth Regulators and Antibiotics on Cotton Seedling Disease when Mixed with the Covering Soil.** C. D. Ranney and L. S. Bird. (*Pla. Dis. Rept.*, **42**, 6, 1958, p. 785.) Fungicides, calcium salts, growth regulators and antibiotics were mixed with the covering soil during planting and tested as control measures to reduce cotton seedling disease losses in Texas. The results showed that the effectiveness of some fungicides against the cotton seedling disease complex was modified by soil pH or conditions associated with soil pH. A mixture of 1½ lb. 50 per cent. captan, 2 lb. 65 per cent. zineb and 1½ lb. 75 per cent. PCNB, however, was found to give a very similar, if not uniform, response over a relatively wide range of both soil temperature and pH, and by using this combination of fungicides as a standard in tests at different locations, a more accurate estimate of fungicide effectiveness on different soil types, moisture conditions and microbial populations could be made. Maneb, thiram, omadine 1562, acti-dione, ceresan 200, panogen 15, calcium chloride, calcium nitrate and gibberellic acid, either alone or in combination with other materials, were shown to be effective in reducing losses from the seedling disease complex in cotton.

**251. The Protective Effect of Some Growth - stimulating Substances and Minor Elements on Cotton Seedling Diseases.** J. S. Hsu and T. H. Chien. (*Acta Phytopath. Sinica*, **3**, 2, 1957, p. 183. In Chinese with English abstract. From *Rev. Appl. Mycol.*, **37**, 7, 1958, p. 410.) At Nanking Agricultural College, in 1955, soaking cotton seed in potassium bromide (0·3 per cent.), hydroquinone (0·3), and manganous sulphate (0·1) reduced the percentage of seedling disease from 100 to 55, 59 and 75, respectively, and increased the rate and amount of germination; ethyl mercuric phosphate (0·05), nicotinic acid (0·01), and 2,4-D (0·5 p.p.m.) reduced disease to 44, 65 and 81 per cent. In 1956 the first three chemicals and nicotinic acid reduced disease from 100 per cent. to 83, 47, 73 and 68 per cent., respectively. None of these proved toxic to *Rhizoctonia solani*, *Colletotrichum gossypii*, or *Fusarium moniliforme*, but ethyl mercuric phosphate had some inhibitory effect.

**252. Bacterial Boll Rot of Cotton (*Xanthomonas malvacearum* (E. F. Smith) Dowson) I.—A Comparison of Two Inoculation Techniques for the Assessment of Host Resistance.** C. Logan. (*Ann. Appl. Biol.*, **46**, 2, 1958, p. 230.) This paper describes and compares for their value in assessing resistance two inoculation techniques, designed to induce infection directly through the boll wall after corolla drop. In the first method, bacterial suspensions were applied with a fine brush

to the outsides of young bolls immediately after corolla drop. In the second, suspensions were inoculated into the wall tissue of bolls three to four weeks old with a fine needle. The second method is the simpler and produces infections in all weather conditions; other advantages are that bolls are inoculated after the period of natural shedding and the circular lesions are easily measured, but a disadvantage compared with the brush method is that the puncture method does not satisfactorily indicate damage to the lint.

Results from the two methods of inoculation suggest that resistance lies in some component of the boll wall tissue that affects bacterial growth and not in a physical factor that prevents the bacteria entering the boll. Variability in resistance occurs in local strains of cotton and this could probably be exploited to give high resistance without the need of a large crossing programme to introduce new genes.

**253. Irrigation and *Verticillium* Wilt Incidence in Cotton.** C. Hughes *et al.* (*Ark. Farm Res.*, 7, 2, 1958, p. 4.) Tests carried out at the Northeast Branch Experiment Station, Arkansas, in 1957 showed that certain commercial varieties of cotton were adversely affected by application of irrigation water. Seventeen varieties were grown on soil known to be infested with *Verticillium* wilt, and three of the seven replications were supplied with one irrigation made by the furrow method, in August.

The results showed a significant increase in wilt incidence for the irrigated plots, but several of the varieties showed very little difference when the wilt percentages for irrigated and non-irrigated plots were compared. The varieties Auburn 56, Stoneville 3202, Delfos 9169, Coker 100 Wilt and Deltapine 15, however, showed increases in wilt incidence ranging from 15 to 26 per cent. which were assumed to be a direct result of the irrigation.

#### GENERAL BOTANY, BREEDING, ETC.

**254. The Effect of Copper on the Growth and Drought Resistance of Cotton Seedlings.** M. H. Kuei and C. Tsui. (*Acta Bot. Sin.*, 6, 1, 1957, p. 73. In Chinese with English summary. From *Field Crop Abs.*, 11, 3, 1958, p. 202.) In northern China the germination percentage and early growth of cotton are usually poor because of drought. The object of the investigation described was to study the effect of copper on seedling growth, and on the water relationship in cotton seedlings. The seeds of three cotton varieties, treated with different concentrations of copper sulphate, were sown in either greenhouse or field. Results showed that the growth of shoots and roots of the treated seeds was much better than that of the controls and that transpiration, water-holding force and suction force of the cotyledons were also increased by treatment. There was indication that higher concentrations of copper sulphate are required in the field than in the greenhouse, and that varieties react differently.

**255. Growth Responses of Cotton and Bean arising from Gibberellin-2,4-D Interaction.** M. A. Clor *et al.* (*Pla. Physiol.*, 33, Proceedings of Meetings Supplement, August 1958, p. 39.) Gibberellic acid and 2,4-D were foliar-applied as small drops. GA-induced shoot elongation of red kidney bean and cotton was inhibited by 2,4-D in amounts of 5 micrograms or more per plant. As a result of this interaction the shoot tip developed into a mass of proliferated tissue. When 2,4-D was applied prior to shoot elongation beyond the primary leaf node of

bean, growth of the terminal bud was completely suppressed; however, about ten days later at this node a secondary shoot developed which elongated in a manner characteristic of GA-treated plants. The deformative effect of 2,4-D on cotton and bean leaves was not altered by GA. With lesser amounts of 2,4-D, the two substances acted synergistically in promoting shoot elongation of cotton seedlings. When both substances were applied to the same primary leaf of bean seedlings, GA also increased the epicotyl curvature which results from 2,4-D application.

**256. Growth and Fruiting Properties and Carbohydrate, Nitrogen and Phosphorus Levels of Cotton Plants as Influenced by Thimet.**  
J. Hacsikaylo. (*J. Econ. Ent.*, **50**, 3, 1957, p. 280. From *Rev. Appl. Ent.*, **46**, Ser. A, 6, 1958, p. 222.) As thimet, applied to cotton seeds in a carbon-impregnated dust, has been found to give excellent control of certain insects attacking the plants for up to six weeks after germination, but to have some phytotoxic properties, investigations were made on the physiological effects of thimet on the plants under optimum conditions of growth.

Cotton plants grown in the greenhouse in sand cultures, to which aqueous emulsions containing technical thimet were added on the tenth day after germination to give concentrations of 10, 100 or 500 parts per million in the nutrient-solution phase of the substrate, all showed initial wilting, but recovered. Slight to severe necrotic flecking of the leaves developed, and was correlated with the concentration of thimet in the substrate. Final dry weights were slightly greater for plants treated with the lowest concentration than for those in untreated substrate, but successively less than the controls at 100 and 500 p.p.m. The number of bolls retained, the yield of seed cotton and the number of seeds per boll and weight of lint per 100 seeds were comparable for no treatment and the two lowest concentrations, but reduced at 500 p.p.m. All treatments resulted in larger seed embryos and tended to cause an increase in their oil content at the expense of protein formulation, but there was no effect on the percentage germination or seedling vigour.

The contents of reducing sugars, sucrose and starch in young plants and of phosphorus, soluble and insoluble in chloroform, in their leaves tended to increase, and those of soluble and protein nitrogen to decrease, with increasing concentrations of thimet.

**257. Fat Utilization and Composition in Germinating Cotton Seeds.** H. B. White. (*Pla. Physiol.*, **33**, 3, 1958, p. 218.) The experiments reported in this paper were undertaken to study the rate of utilization and the composition of the fat reserve during cotton seed germination under various growth conditions. To correlate the decrease in fat content with the growth of the seedlings, measurements were made of the development of the root, hypocotyl and cotyledons.

The seedlings with roots 7 to 12 mm. long were grown in solution cultures at 30° C. in continuous light and in complete darkness, and the plants were harvested at various times during the 7-day growth period. After a large loss in the first 1.5 days, the dry weight of the seedlings in the dark did not continue to decrease. Current photosynthate exerted no apparent sparing action on depletion of the fat reserve. Fat utilization was more rapid in the light than in the dark.

During all stages of fat utilization there was only a small and relatively constant amount of free fatty acids in the cotyledons. From 2 through 5 days the rate of fat disappearance followed the equation for a first-order

chemical reaction. Similarly the rate of depletion of linoleic acid, oleic acid and the saturated acids was constantly proportional to the amount of each of these acids, respectively, in the fat reserve.

During utilization of the storage fat, the iodine value and the percentage of linoleic acid decreased, the percentage of oleic acid increased, and the percentage of saturated acids remained steady during the first 4 days and then dropped.

When seedlings were allowed to develop in the dark in temperatures ranging from 20° to 39° C., there was no alteration in the pattern of fat utilization found at 30° C. Under all germination conditions tested, the fat composition was the same function of the total amount of fatty acids remaining in the fat reserve; it was independent of the rate or type of seedling development. Linoleic acid and the saturated acids were depleted relatively faster than oleic acid.

**258. Performances of Some Wide Crosses in *Gossypium*.** P. A. Fryxell et al. (*New Mexico Agric. Exp. Sta. Bull.* 419, May 1958.) A study of thirty-six hybrids of cotton (generally *Gossypium hirsutum* × *G. barbadense*) together with the parental varieties was conducted. Results are reported for ten agronomically important characters concerned with productivity and fibre quality. The data are considered from the viewpoint of the combining ability of the parental lines tested, considering the introgression of germ plasm from one species to the other, and from the viewpoint of the possible use of such inter-specific hybrids as a commercial crop to combine the more desirable traits of each of the two species.

The phenotypic stability of the hybrids for certain traits is discussed. Certain of the hybrids, notably Pima 32 × Acala 1517C, seem well adapted to commercial production and provide distinct advantages over either parent. Pima 32 and Acala 1517C were also outstanding in general combining ability. The two species concerned show a similar range of expression for fibre elongation, but the hybrids extend this range beyond either parent in the direction of greater elongation.

#### FIBRES, YARNS AND SPINNING

**259. Effects and Costs of Cleaning Lint in Arkansas Cotton Gins.** C. C. Cable and Z. M. Looney. (*U.S.D.A. Agric. Mktg. Serv., Bull.* 595, December 1957.) The object of this study was to evaluate lint cleaning in Arkansas in relation to its effect on certain quality characteristics, and to estimate the additional cost of providing this ginning service. For practical purposes it was found that its effect on staple length was unimportant, but approximately 40 to 50 per cent. of the bales studied were raised into the next higher grade regardless of method of harvest. As regards spinning performance, lint cleaning generally increased the nep count, but differences were very small. Yarn strength was slightly increased, and there was a small adverse effect on yarn appearance. Spinning waste was significantly reduced, in some cases to the equivalent of a full increase in grade. Reduction in weight of a 500 lb. bale ranged from 0.8 to 58.1 lb., from 65 to 96 per cent. of the waste removed being non-fibrous material.

Although lint cleaning raised the grade of from 40 to 50 per cent. of the bales, the gross bale value might actually have been reduced because the reduction in bale weight more than offset the gain in value due to grade improvement at average premiums and discounts for the period 1949-54.

Details of capital investment, labour and maintenance costs for the additional machinery and processes involved are also given.

**260. Effect of Opening and Cleaning Processes on Fibre.** J. C. Hubbard and J. S. Graham. (*Text. Indus.*, 122, 1958, p. 150. From *Text. Tech. Digest.*, 15, 7, 1958, Abs. 2423.) An investigation of the effect of various degrees of opening and cleaning indicated that when bales of California SLM cotton were processed with conventional machinery, the number of processes used appeared to be critical. Although nep count seemed to increase with degree of opening and cleaning, the rate of increase was not great for tests using not more than two openers. With the addition of a third opener, the nep count rose sharply.

**261. Influence of Weathering Prior to Harvest on Certain Properties of Cotton Fibres.** P. B. Marsh *et al.* (*Text. Res. J.*, 28, 1958, p. 95. From *Text. Tech. Digest.*, 15, 4, 1958, Abs. 1133.) Most of the commercial cotton fibre produced in the United States is subjected to a period of from one to many weeks of exposure to the weather before it is harvested. Such weathering has been shown in prior work to be a cause of changes in the wax on the fibre, in the fibre's swelling behaviour in alkali, and under humid conditions, in the pH of water extracts of the fibre. Subsequent investigations have revealed that a number of other fibre properties also may undergo change during preharvest weathering, including moisture regain at constant relative humidity, dye absorption, content of water-soluble reducing substances, browning tendency, rate of wetting in a water-alcohol mixture, length, strength and susceptibility to enzymatic decomposition. The X-ray angle showed little if any alteration. Several of the fibre properties which change during weathering have been measured on commercial fibre samples and the results found to show a relationship to the grade of the fibre. A rapid and practical test for measuring the water-soluble copper-reducing constituents in raw cotton fibre is described.

**262. Standardization of the Nep-counting Technique for Cotton Lint.** C. Nanjundayya *et al.* (*Ind. Text. J.*, 68, 1958, p. 222. From *B.C.I.R.A. Summ. Curr. Lit.*, 38, 12, 1958, p. 377.) An investigation was carried out on Indian cottons to determine the various difficulties and errors involved in nep counting on lint and yarn samples. As a result of the findings of this study, a standard method for the determination of neps in raw cotton is recommended. Representative pinches (about 32) are taken at random from the sample so as to get a total weight of about 300-500 mg. Small tufts are separated out from this sample and laid on black cards (4 in all) in the form of a thin web. Each card is covered with a Perspex sheet suitably ruled into rectangular areas. Examination is carried out under a lens having a magnification of about 4. Neps formed of (i) fibres (F), (ii) seed-coat fragments (S), and (iii) leaf fragments (L) are counted and recorded separately. The nep index, N, is given by  $N = F + S + 0.05L$ .

**263. Measuring Cotton Fibre Length by the Truncated Array Method.** F. Carpenter and S. T. Burley. (U.S. Dept. Agric., Marktg. Res. Rep. No. 217.) A description is given of the truncated array technique for measuring fibre length. This method is a variation of the Suter-Webb array technique and uses the same equipment. In comparative tests, however, the truncated array technique was found to give more reliable results for all tests for cotton fibre length where previously the standard Suter-Webb array upper quartile length, mean length and coefficient of length variability were adequate, and to be

15 per cent. quicker in operation. For length tests requiring other values, the standard Suter-Webb array procedure should be followed.

**264. Industrial Fibres.** (Commonw. Econ. Cttee., H.M.S.O., 1958. Price 5s. net.) This review continues the series issued annually by the Committee for the purpose of presenting current summaries of production, international trade and consumption for cotton and other natural and man-made fibres, with special reference to the part played by Commonwealth countries. Statistics cover the post-war seasons up to 1956-57 with comparisons for the pre-war period.

**265. The Cotton Industry in a World Economy.** (Int. Fedn. Cott. and Allied Text. Industries, Manchester, England, 1958.) This publication comprises the presidential address and papers presented at the International Cotton Conference held at Venice, Italy, from September 22 to 28, 1957, under the auspices of the International Federation of Cotton and Allied Textile Industries. The purpose of the conference was to review the existing status of the industry and to make an assessment of its potentialities and prospects. More than 300 delegates representing sixteen nations attended the conference, and papers were submitted from the United Kingdom, Germany, India, Japan, the United States of America, Holland and France. The paper by Dr. W. T. Kroese entitled "The Cotton Industry of Western Europe in a Changing World" includes 29 charts and 29 tables giving valuable information on the relation of the industry to world markets. In the preface the Director of the Federation comments on the remarkable unanimity of views expressed at the conference, and the notable spirit of community and interdependence currently existing among cotton and allied textile industrialists.

## CURRENT NOTES

MR. H. L. MANNING, Director of the Namulonge Research Station, Uganda, read a paper on the relationship between soil moisture and yield variation in cotton at the Colonial Office Conference of Directors of Agriculture in the Colonies held at the South-Eastern Agricultural College, Wye, from September 8-13. Mr. J. C. May, C.M.G., O.B.E., Director of the Corporation, and Mr. D. F. Ruston, Secretary, also attended the Conference.

Dr. S. O. S. Dark (Shambat, Sudan) read a paper on blackarm resistance in cotton at the Tenth International Congress of Genetics held at McGill University, Montreal, from August 20-27.

Mr. A. M. Kabaara (Ukiringuru, Tanganyika) will enter Aberdeen University in October to attend a year's post-graduate course in soil science.

The following members of the staff are now on leave in the United Kingdom or will shortly be arriving, and are due to leave on or about the dates shown:

Mr. H. L. Manning	Uganda	October 12
Mr. R. C. Faulkner	Sudan	October 15
Mr. J. D. Lea	Uganda	October 21
Dr. G. M. Wickens	Uganda	October 30
Mr. H. G. Farbrother	Uganda	November

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7-9-67		
30 APR 1967		
- 3 NOV 1970		
- 5 DEC 1970		